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CYCLOPIDES (CRUSTACÉS COPÉPODES) DE L'INDE.

V. CONTRIBUTION À L'ÉTUDE DU GENRE *HALICYCLOPS* NORMAN.

Par KNUT LINDBERG.

Halicyclops canui, sp. nov.

Description.—Longueur 845 μ ; céphalothorax 598 μ , queue (abdomen+furca sans soies apicales) 247 μ ; largeur 313 μ ; longueur du premier segment céphalothoracique 294 μ . Segment génital se rétrécissant très légèrement du côté distal; les parties latérales présentent vers le milieu du segment une protubérance assez marquée. Bord postérieur du troisième segment abdominal découpé sur la face dorsale en petites dents indistinctes. Segment anal profondément divisé. Branches de la furca parallèles, moins de 1.5 fois aussi longues que larges ($33 : 23\mu = 1.43 : 1$). Soie latérale externe divisant la branche de la furca dans la proportion 16 : 17. Soie dorsale assez longue (50 μ), surpassant

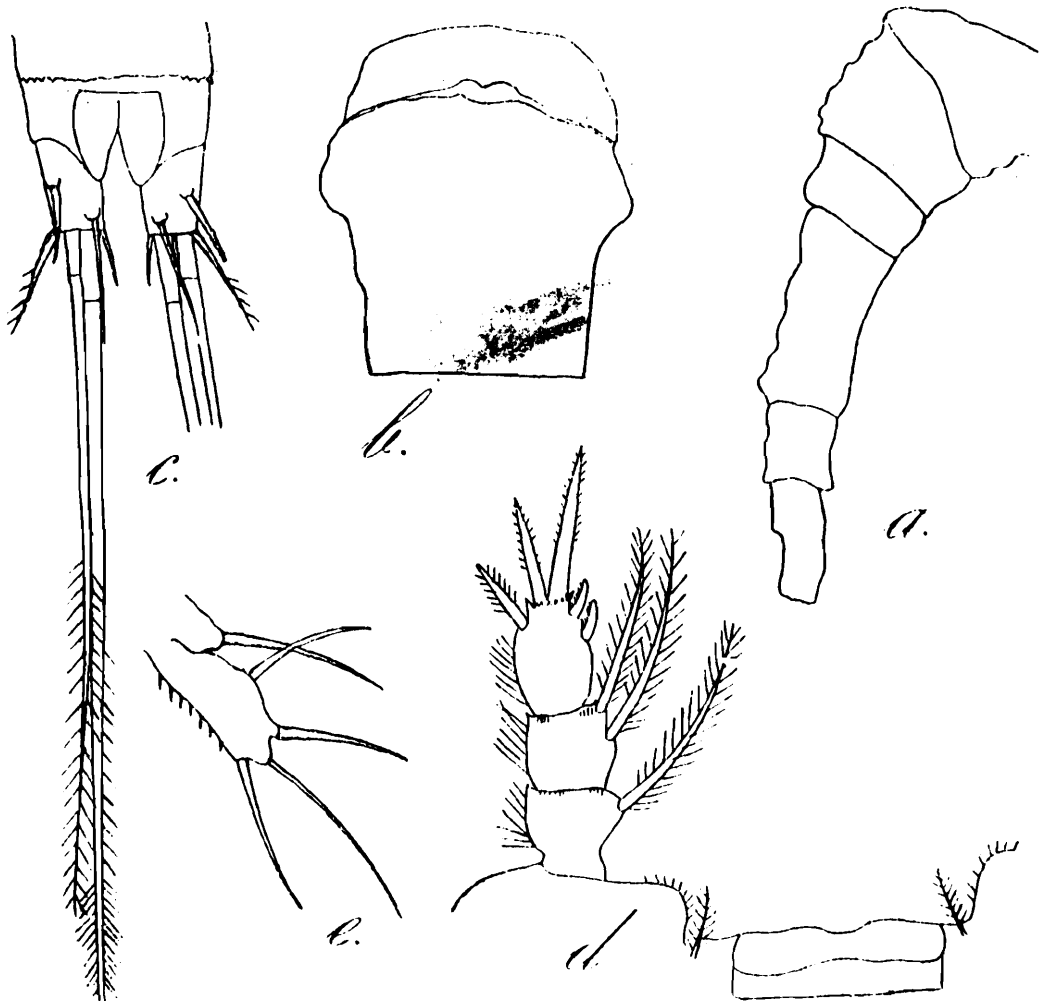


Fig. 1. *Halicyclops canui*, sp. nov. ♀.

a. Première antenne; b. Segment génital; c. Furca, face dorsale; d. Enp. 4 et lamelle basale; e. P 5.

légèrement la longueur de la soie apicale externe. Celle-ci deux fois plus longue que la soie apicale interne. Soie apicale médiane externe

moins que la moitié de la longueur de la soie apicale médiane interne. Les deux soies apicales médianes ne portent que des cils, dont la disposition est représentée sur la figure. Longueurs respectives des soies apicales 45 : 234 : 529 : 22 μ . Première antenne à 6 articles. Branches des pattes natatoires triarticulées. Formule des épines 2·3·3·3 Article 3 de l'emp. 4 moins que deux fois aussi long que large (45 : 24 μ = 1·87 : 1). Epine apicale interne dépassant en longueur aussi bien celle de l'épine apicale externe que celle de l'article. Epine apicale interne : épine apicale externe 67 : 47 μ = 1·43 : 1 ; épine apicale interne : article 67 : 45 μ = 1·49 : 1. Epine du rebord externe de l'article terminal de l'emp. 4 de structure normale ; les deux soies du rebord interne de cet article transformées en deux petites épines obtuses, portant des cils gros et courts. Lamelle basale de la quatrième paire de pattes offrant un aspect particulier, étant très élargie mais de faible hauteur. Le premier article de la cinquième patte ne forme qu'une protubérance soudée au segment thoracique, portant une longue soie, et ne présente rien de distinctif. Le deuxième article montre l'aspect décrit par Sewell chez *H. tenuispina*, c'est-à-dire les 3 épines sont très allongées et amincies et peu différentes de la soie. Le réceptacle séminal n'a pas pu être distingué. Ovisacs allongés, dépassant l'extrémité de la furca, étroitement appliqués contre l'abdomen. Ils contenaient chacun 13 oeufs. Mâle inconnu.

Habitat.—Les marais à Bandra mentionnés au sujet de l'espèce suivante. Une seule femelle récoltée au mois d'octobre.

Remarques.—L'espèce qui vient d'être décrite se rapproche de *H. tenuispina* découvert dans le lac Tchilka sur la côte Nord-Est de l'Inde. A part des épines effilées de P 5 l'espèce de Sewell montre une modification curieuse des épines marginales des exopodites des pattes natatoires, ces épines ayant un aspect en massue, particularité que ne présente pas la forme dont il s'agit ici. De plus, d'après le texte de Sewell, la formule des épines de *H. tenuispina* est de 4·4·4·3 (la figure de l'exopodite de P 4 montre cependant 4 épines). Par suite de ces différences importantes il est nécessaire de considérer l'animal de Bandra comme représentant une espèce nouvelle. Je l'ai nommé en souvenir de l'auteur des "Cépépodes du Boulonnais", E. Canu.

Halicyclops thermophilus spinifer Kiefer.

Description.—Longueur de la femelle ovigère de 589 μ à 784 μ (moyenne, animaux de l'Inde 688 μ , ceux de l'Iran 661 μ) ; largeur de 224 μ à 285 μ (moyennes 258 μ et 234 μ respectivement). Segment génital présentant latéralement vers le milieu, à la limite de fusion des deux segments originaux, une forte épine chitineuse, dirigée vers le bas. Bords postérieurs des segments abdominaux découpés sur la face dorsale en petites dents plus ou moins distinctes. Ces dents sont sur le milieu du rebord postérieur du troisième segment abdominal considérablement plus grandes que sur les parties latérales du même segment. Chez quelques animaux je n'ai pourtant pas pu distinguer cette dentelure. Segment anal profondément fendu, divisé presque en deux moitiés. Le bord postérieur de ce segment porte sur la face ventrale une rangée de petites épines. Bord libre de l'opercule anal

lisse ; chez un seul animal il était pourvu de spinules extrêmement petites. Dans l'échancrure anale on distingue parfois des rangées de petites dents minuscules. Branches de la furca un peu plus longues que larges, le rapport variant de 1.15 : 1 à 1.50 : 1 avec une moyenne de 1.33 : 1 chez les animaux de Bombay et de 1.39 : 1 chez ceux du golfe Iranien. Elles sont le plus souvent fortement divergentes mais peuvent aussi être parallèles, même chez des femelles adultes, étant sans doute mobiles. Soie latérale externe forte mais courte, insérée en général en avant du milieu de la branche de la furca et rarement au milieu même.

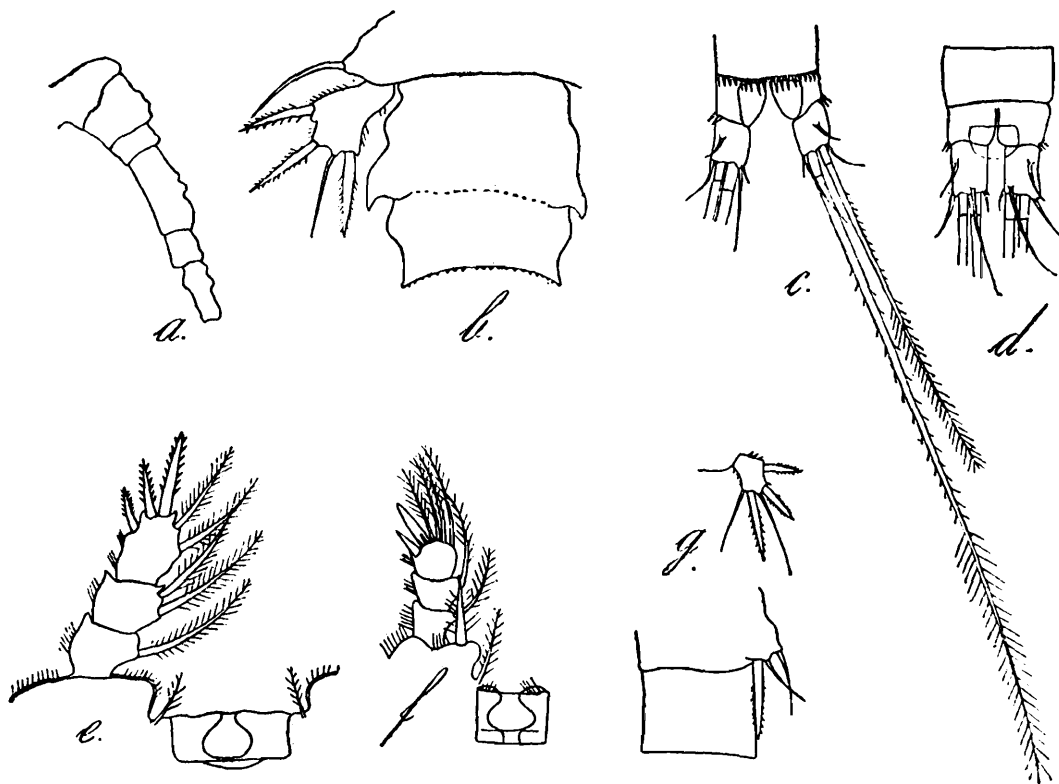


Fig. 2. *Halicyclops thermophilus spinifer* Kiefer. Spécimens de Bandra.

a. ♀ Première antenne ; b. ♀ P 5 et segment génital ; c. ♀ Furca, aspect dorsal ; d. ♀ Furca autre spécimen ; e. ♀ Enp. 4 et lamelle basale ; f. ♀ Enp. 1 et lamelle basale ; g. ♂ P 5 et P 6.

Soie dorsale assez longue, prenant origine sur une petite protubérance qui ne dépasse pas l'extrémité de la branche de la furca. Soie apicale externe assez bien développée, environ deux fois aussi longue que la soie apicale interne. Chez les spécimens indiens leur rapport de longueur moyenne était de 1.94 : 1 ; chez ceux de l'Iran la soie apicale externe était plus de deux fois aussi longue que la soie apicale interne (rapport 2.18 : 1). Soie apicale médiane interne moins que deux fois aussi longue que la soie apicale médiane externe ; leur pennation est hétéronyme et se voit sur les figures. Première antenne courte composée de 6 articles. Pattes natatoires tri-articulées. La soie située sur la base de la première paire de pattes a l'aspect d'une forte épine portant de longs cils. Formule des épines 3.4.4.3. Article terminal de l'endopodite de P 4 environ 1.5 fois aussi long que large (rapport moyen 1.49 : 1 pour les animaux de l'Inde et 1.57 : 1 pour ceux de l'Iran). Epine apicale interne plus longue que l'article et considérablement plus longue que l'épine apicale externe ; rapport moyen épine interne : épine externe 1.42 : 1 (Inde), 1.34 : 1 (Iran) ; rapport épine interne ; article

1.29 : 1 et 1.17 : 1 respectivement. Épine du rebord externe du même article un peu moins longue que l'épine apicale externe ; les deux soies du rebord interne sont de structure normale. La configuration de la lamelle réunissant la base de la quatrième paire de pattes est représentée sur les figures. Article 2 de la cinquième patte à 4 appendices, dont les 3 épines sont assez allongées. Des mensurations de leurs longueurs respectives sont données sur le tableau, l'ordre pris étant du dedans au dehors, le deuxième chiffre représentant par conséquent la mesure de la soie. Ovisacs grands, allongés, dépassant l'extrémité de la furca ;

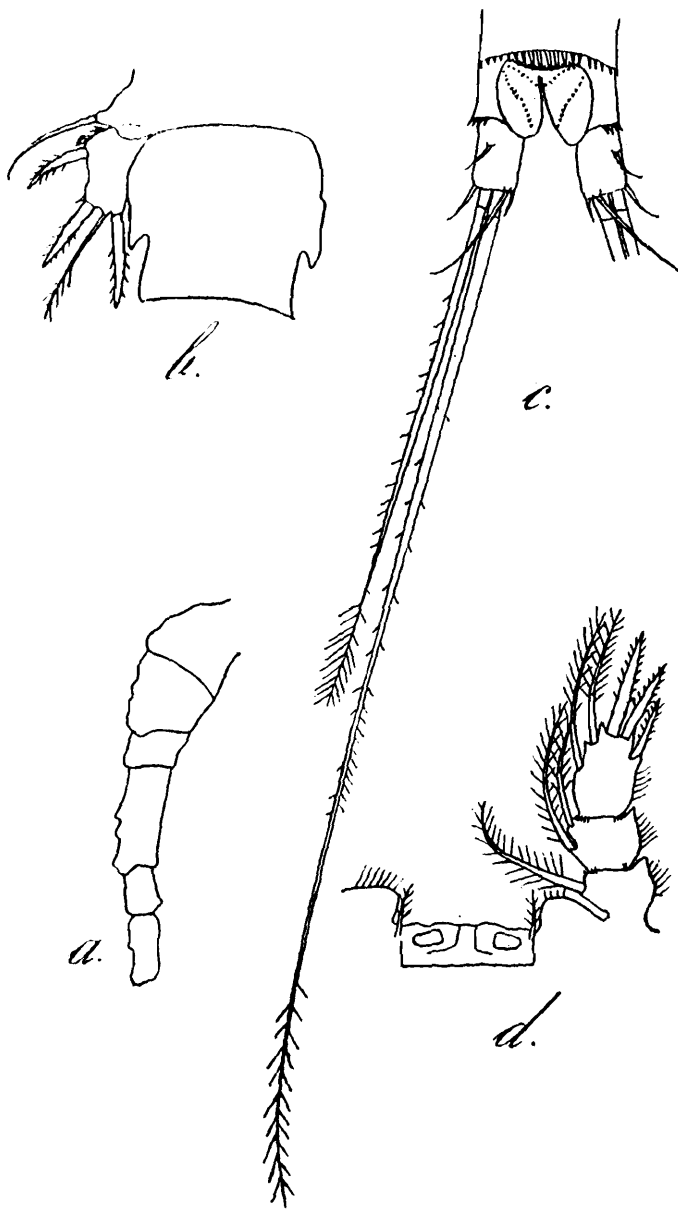


Fig. 3. *Halicyclops thermophilus spinifer* Kiefer. Spécimens de Parak.

a. ♀ Première antenne ; b. ♀ P 5 et segment génital ; c. ♀ Furca, aspect dorsal ; d. ♀ Enp. 4 et lamelle basale.

chez la plupart des individus ils étaient accolés contre l'abdomen. Le plus petit nombre d'oeufs comptés dans un ovisac a été de 8, et le plus grand de 23 ; en moyenne chaque ovisac contenait 15 oeufs. Mâle, longueur de 494 à 513 μ ; largeur de 152 à 167 μ (3 spécimens seulement examinés). Branches de la furca parallèles de 1.25 à 1.47 fois aussi longues que larges. Article 2 de P5 portant 3 épines et 2 soies. P6 composée de 3 appendices ; une longue épine interne, ne dépassant

cependant pas le rebord postérieur du deuxième segment abdominal, et 2 soies, dont la plus interne (l'appendice médian) est très mince et plus courte que la soie externe.

Habitats.—(1) Des marais à eau saumâtre à Bandra et à Kourla (faubourgs de Bombay) avec *C. (M.) dengizicus* Lepechkin, au mois d'octobre.

(2) Un étang salin près du bord de la mer, à 2 kilomètres au sud de Parak, village de pêcheurs, environ mi-chemin entre Bouchir et Linguéh, avec *C. (M.) minutus* Claus et *C. (M.) grandispinifer* Lindberg, au mois de février.

Les animaux étudiés proviennent, dans le cas de ceux de l'Inde, de plusieurs parties différentes des marais à Bandra ; ceux de l'Iran ont été récoltés à un même endroit. Toutes les femelles étudiées de Bandra portaient des ovisacs. Seulement la dernière (sur le tableau) des femelles rapportées de Parak était ovigère. Aucun mâle n'y fut trouvé.

Remarques.—C'est en 1925 que Kiefer a fait connaître le premier *Halicyclops* à segment génital pourvu d'épines latérales, le *Halicyclops thermophilus* de Java, et 10 ans plus tard a été décrite la variété *spinifer* d'après des spécimens récoltés à Port Canning, près de Calcutta. De voir en ces animaux une sous-espèce du premier semble en effet tout à fait juste, mais, chose étrange, d'après Kiefer ce n'est pas la similitude de configuration du segment génital qui constitue la raison d'être de cette parenté, mais la dentelure du troisième segment abdominal, car Kiefer a en même temps introduit encore une sous-espèce, le *Halicyclops thermophilus septentrionalis*, dont le segment génital est dépourvu d'épines et présente les protubérances latérales usuelles des autres membres du genre *Halicyclops*. Même s'il est certain que la dentelure particulière en question existe chez tous les individus référables à la variété *H. thermophilus spinifer* il semble bien singulier de voir en cette ornementation une qualité phylogénétique plus importante qu'une modification structurale profonde du segment génital même. Il est évident que la forme qui vient d'être décrite est identique au *Halicyclops thermophilus spinifer* de Calcutta. Les divergences que présentent les animaux du golfe Iranien me semblent trop peu marquées pour nécessiter leur distinction comme une variété différente.

Quelques remarques s'imposent encore au sujet de la nomenclature. Kiefer a en 1936, après avoir démembré en plusieurs espèces le *Halicyclops aequoreus*, considéré jusqu' alors comme une forme cosmopolite, trouvé utile d'abandonner le nom de Fischer en faveur de celui de Boeck (*H. christianiensis*). Ses raisons sont, d'une part la description défectueuse de Fischer, d'autre part la supposition que le *Halicyclops* décrit par Lilljeborg, Boeck et Sars, c'est-à-dire la forme commune dans l'Europe du Nord, n'existe pas à Madère, d'où provenaient les animaux de Fischer. Cependant ce travail a eu le mérite de montrer l'incertitude qui subsiste sur l'identité réelle des animaux exotiques simplement mentionnés comme "*Halicyclops aequoreus*" ou "*magniceps*", et, en ce qui concerne l'étude présente cette remarque s'applique au sujet de "*H. magniceps*" rapporté par Seymour Sewell du lac Tchilka et de "*H. aequoreus*" de Rylov, trouvé à Bender Pahlévi sur les bords de la mer Caspienne,

Halicyclops thermophilus spinifer Kiefer.

Localité.	Longueur	Furca Long. : larg.	Soies apicales.	Enp. 4. Art. 3. Long. : larg.	Enp. 4. Art. 3. Ep. int.: ép. ext.	Enp. 4. Art. 3. Ep. int. : long. art.	P 5. Art 2. Appendices (du dedans au dehors).	P 6 Ep.: soie méd.: soie ext.
Bandra	684	33 : 25=1.32 : 1	22 : 320 : 459 : 17	37 : 27=1.37 : 1	43 : 33=1.30 : 1	43 : 37=1.16 : 1	44 : 43 : 40 : 37	
	617	33 : 23=1.43 : 1	25 : 217 : 392 : 13	37 : 23=1.60 : 1	47 : 30=1.57 : 1	47 : 37=1.27 : 1	..	
	712	30 : 21=1.43 : 1	33 : 203 : 367 : 15	30 : 22=1.36 : 1	40 : 28=1.43 : 1	40 : 30=1.33 : 1	..	
	722	31 : 22=1.41 : 1	38 : 230 : 431 : 13	37 : 25=1.48 : 1	50 : 35=1.43 : 1	50 : 37=1.35 : 1	40 : 43 : 37 : 37	
	589	23 : 20=1.15 : 1	27 : 192 : 384 : 13	33 : 22=1.50 : 1	42 : 32=1.31 : 1	42 : 33=1.27 : 1	47 : 37 : 40 : 37	
	784	27 : 21=1.29 : 1	35 : × : 417 : 16		..			
	712	30 : 23=1.30 : 1	27 : 242 : 442 : 20	37 : 23=1.60 : 1	50 : 33=1.52 : 1	50 : 37=1.35 : 1		
	♂494	25 : 17=1.47 : 1	20 : 167 : 325 : 11	27 : 13=2.08 : 1	37 : 23=1.60 : 1	37 : 27=1.37 : 1		33 : × : 30
	♂503	20 : 16=1.25 : 1	25 : 170 : 310 : ×	25 : 16=1.58 : 1	37 : 25=1.48 : 1	37 : 25=1.48 : 1	..	33 : 25 : 33 27 : 22 : 25
	♂513							
Parak	636	30 : 22=1.36 : 1	33 : 217 : 404 : 16					
	622	30 : 22=1.36 : 1	33 : 214 : 392 : 16	33 : 23=1.43 : 1	42 : 30=1.40 : 1	42 : 33=1.27 : 1	..	
	694	32 : 22=1.45 : 1	37 : 220 : × : 15	37 : 23=1.60 : 1	45 : 33=1.36 : 1	45 : 37=1.22 : 1	42 : × : 42 : 33	
	646	32 : 22=1.45 : 1	33 : 220 : 395 : 16		....		
	627	25 : 20=1.25 : 1	28 : 212 : 372 : 16	40 : 23=1.74 : 1	43 : 33=1.30 : 1	43 : 40=1.07 : 1	42 : × : 33 : 33	
	703	28 : 20=1.40 : 1	30 : 210 : 386 : 13		..	..	45 : 37 : 40 : 38	
	703	33 : 22=1.50 : 1	35 : 207 : 437 : 13	38 : 25=1.52 : 1	43 : 33=1.30 : 1	43 : 38=1.13 : 1		

RÉSUMÉ.

Une description a été donnée d'une espèce nouvelle du genre *Halicyclops* et une rédescription d'une forme du même genre déjà connue de la côte orientale de l'Inde et retrouvée sur la côte occidentale, ainsi que sur le littoral du golfe Iranien.

Quelques remarques ont été faites au sujet de la nomenclature récente de Kiefer.

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SILUROID FISHES OF INDIA, BURMA AND CEYLON.

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(Plates I and II.)

IX. FISHES OF THE GENERA *Gagata* BLEEKER AND *Nangra* DAY.

Recently while working out collections of freshwater fishes from Assam and Travancore, considerable difficulty was experienced in separating Indian species hitherto referred to the genera *Gagata* Bleeker, *Batasio* Blyth and *Nangra* Day. This led us to examine the entire material of these genera in the extensive collections of the Indian Museum with very interesting results. In this article we propose to deal with the fishes of the genus *Gagata*, of which *Nangra* is regarded as a synonym, while the genus *Batasio* is treated in detail in the next article of this series.

Gagata Bleeker.

1858. *Gagata*, Bleeker, *Ichthyol. Archipel, Ind. Prodromus*, I, p. 204 (orthotype *G. typus* Blkr. = *Pimelodus gagata* Ham.).
1860. *Gagata*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 152.
1863. *Gagata*, Bleeker, *Ned. Tijdschr. Dierk.* I, p. 90.
1864. *Callomystax*, Günther, *Cat. Fish. Brit. Mus.* V, p. 218.
1877. *Gagata*, Day, *Fish. India*, p. 492.
1877. *Nangra*, Day, *ibid.*, p. 493.
1911. *Gagata*, Regan, *Ann. Mag. Nat. Hist.* (8) VIII, p. 564.
1911. *Nangra*, Regan, *ibid.* (8) VIII, p. 564.
1913. *Gagata*, Weber & de Beaufort, *Fish. Indo-Austral. Archipel.* II, p. 268.

In 1858, Bleeker provisionally proposed the generic name *Gagata* and included a number of heterogeneous forms in it. It was not until 1863, however, that its definition was given and *Pimelodus gagata* Hamilton, rechristened as *Gagata typus* Bleeker, definitely assigned to it. As Bleeker had not seen any specimen of Hamilton's species, his characterisation of the genus was imperfect and the systematic position he assigned to it was faulty. However, Blyth recognised *Gagata* as a valid genus, but remarked: "This, as it now stands, is a heterogeneous assemblage of species, and I know of none that can properly range with the type of it, which is *Pimelodus gagata*, B. H.: a species with the maxillary cirri bony towards the base, as in *Bagarius* to a much greater extent. The *Menoda* dubiously referred to this type by Dr. Bleeker is identical with *Bagrus corsula*, Val., which therefore must stand as *B. menoda* (B. H.); the *Mangois* appertaining to my genus *Amblyceps*; and another type may be here indicated as—*Hara*, nobis, n.g." Günther redescribed the species *gagata* from 5 examples, which he regarded as "Types of the species. Presented by G. R. Waterhouse, Esqr.," and erected for it a new genus *Callomystax*. He was aware of Bleeker's *Gagata* but did not consider it a valid genus and remarked:

"Dr. V. Bleeker does not appear to have been acquainted with this fish, so that not only the characters of the genus which he proposed for it are incorrect, but it is also improperly referred to the 'phalanx' of *Arii*, and to the 'Stirps' of *Bagrini*."

Later workers, however, regarded *Gagata* Bleeker as a valid genus and considered Günther's *Callomystax* as its synonym. Günther had assigned only one species to this genus, but Day included 4 species in it—*G. cenia* (Ham.) with *G. gagata* (Ham.) as a synonym, *G. itchkeea* (Sykes), *G. batasio* (Ham.) and *G. tengana* (Ham.). According to Day, the range of the genus extends from the "Rivers of Sind, India (except Madras) and Burma." One more species—*G. schmidtii*—has since been described by Volz¹ from Sumatra.

Day established another genus *Nangra* to accommodate *Pimelodus nangra* Hamilton, *P. viridescens* Hamilton and a new species from the Sone River (*Nangra punctata*) and remarked :—

"This genus differs from *Gagata* in its barbels not being placed in a transverse line behind the chin: and in its gill-membranes not being confluent with a broad isthmus but rather deeply notched. It is allied in some respects to *Macrones*, but has no teeth on the palate, whilst its air-vessel is enclosed in bone."

Our studies have shown that the characters distinguishing the two genera intergrade into each other and can at best be used for separating species in the same genus.

In order to discuss the systematic position of the above-mentioned species, it is necessary to know, in the first instance, the precise limits of the genus *Gagata* Hamilton. Though quite a number of Hamilton's species are inadequately characterised, there is no difficulty in recognising *P. gagata*, as its detailed description and figure leave no doubt about its identity. Reference may here be made to a few of its most salient features as given by Hamilton.

- i. There are eight barbels; the two nasal and the four mandibular barbels are shorter than the head, while the maxillary barbels are rather longer, and have a membrane extending half way along their hinder edge.
- ii. The anal fin is provided with 17 rays.
- iii. The fins are edged with black.
- iv. The bones of the head are roughened with variously intersecting ridges.
- v. The jaws are crowded with minute teeth, while the tongue and the palate are smooth.
- vi. Both apertures of each nostril are circular and are separated only by the nasal barbel.

Bleeker (1863, p. 90) based his genus *Gagata* on the following characters :—

"Cirri 8, nasales 2, supramaxillares 2, inframaxillares 4. Palatum edentulum. Dentes maxillis pluriseriati parvi. Scutum capitis granosum, fonticulis lateralibus. Cirri supramaxillares basi membrana muniti. Spina dorsi edentula. B. 5."

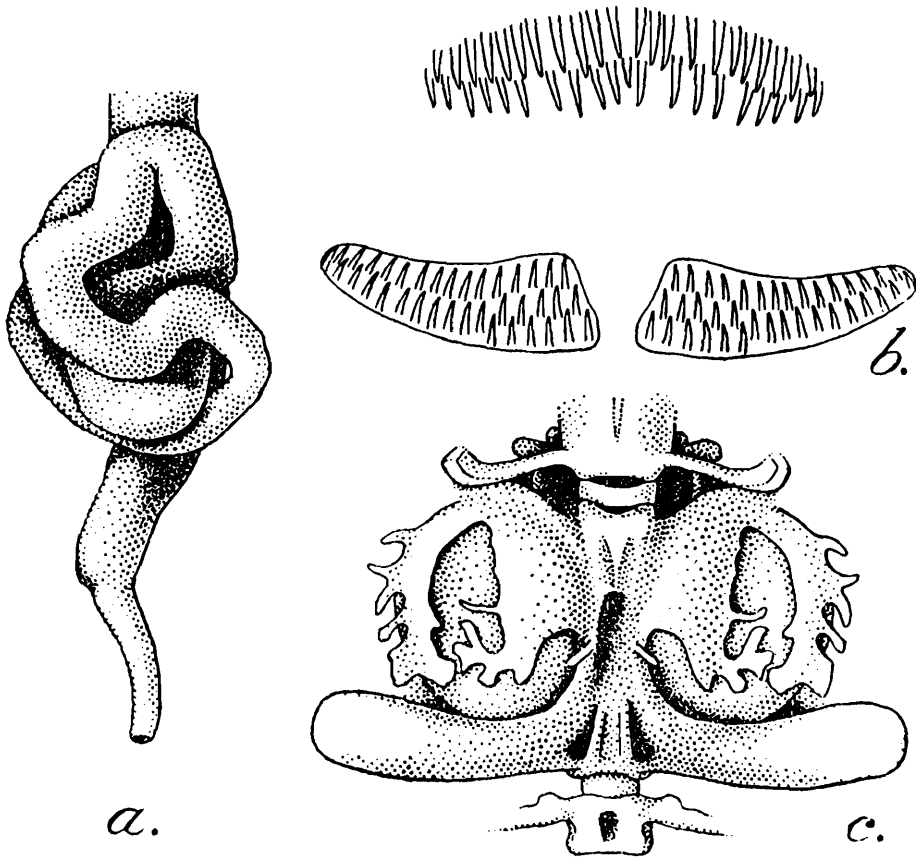
Günther gave a good definition of the genus under *Callomystax* and included the following additional important diagnostic characters in it :—

- i. The two pairs of mandibular barbels are inserted in a transverse series immediately behind the margin of the lower lip. The maxillary barbels are osseous to some extent.
- ii. The eyes are without free orbital margins.

¹ Volz, W., *Revue Suisse de Zool.* XII, p. 470 (1904).

- iii. The gill-openings are of moderate width, the gill-membranes being confluent with the skin of the isthmus.

Day added to the generic definition the character of the air-bladder which he found to consist of "two rounded portions, each of which is enclosed in an osseous cup." Regan in his synopsis of the genera of the Sisoridae defined the main skeletal features of *Gagata* and *Nangra*.



Text-fig. 1.—Alimentary canal, dentition and air-bladder of *Gagata gagata* (Hamilton).

a. Alimentary canal. $\times 2\frac{1}{2}$; b. Dentition. $\times 8$; c. Air-bladder. $\times 3\frac{3}{4}$.

In view of what is stated above, the genus *Gagata* may be defined as follows:—

Gagata comprises a group of Sisorid fishes in which the body is compressed and the snub-nosed head, though globular, is somewhat elevated, only rarely depressed. The upper surface of the head is provided with sharp, longitudinal ridges; it is covered with thin, smooth skin, but some of the bones on the dorsal surface are variously roughened. The median fontanel is very conspicuous. The mouth is small, transverse and ventral. The lips are thick, continuous and somewhat fimbriated; the post-labial grooves are restricted round the corners of the mouth. The jaws are provided with small, villiform teeth; the palate is edentulous. There are eight barbels; the nasal barbels are small and thin and are prolongations of the broad flaps separating the two nostrils on each side; these flaps, when present, cover a part of the posterior nostrils on each side; the maxillary barbels are osseous proximally, and are provided with membraneous flaps along the inner surface; the two pairs of mandibular barbels are shorter and may or may not be situated in a more or less transverse series behind the posterior lip.

The skin in the thoracic region is smooth. The nostrils are close together. The eyes are subcutaneous. The gill-openings are fairly wide; the gill-membranes may be confluent with the skin of the isthmus, or deeply notched. The rayed dorsal fin is provided with a strong spine. The adipose dorsal is short but prominent. The pectorals are provided with strong spines which are denticulated internally. The pelvics are horizontal and 6-rayed; they are situated behind the dorsal. The anal fin is short. The caudal fin is deeply forked. The air-bladder is divided into two rounded portions which are partially enclosed in bone and come in direct contact with the skin above the pectorals. There are 5 to 7 branchiostegal rays.

Regan distinguished *Gagata* from the other genera of the Sisoridae by the following combination of characters:—

“ Praecaual vertebrae normal, with the ribs attached to the simple parapophysis and the neural arches without the lateral processes; end of transverse process of fifth vertebra appearing as a rugose plate behind the lateral cutaneous area.

“ Head somewhat compressed and elevated; tail and caudal vertebrae normal.

“ Mesopterygoid smaller than metapterygoid, pelvis behind the dorsal.

“ Gill-membranes attached to isthmus.”

Further, he distinguished *Nangra* from *Gagata* by the fact that in the former the gill-membranes are free from the isthmus.

Having defined the generic limits of *Gagata* and *Nangra* we may now consider the systematic position of the various species assigned to these genera. Hamilton's *Pimelodus cenia* is undoubtedly congeneric with his *P. gagata*. In the former the author seems to have overlooked the minute nasal barbels. Günther appears to have overlooked this species entirely, for there is no mention of it in his *Catalogue*. Though in 1869, Day¹ recognised it as a distinct species, in his *Fishes of India* and the *Fauna* he considered it as a young form of *Gagata gagata*. We have examined a large series of specimens of both the species in the collection of the Indian Museum and are definitely of the opinion that they are quite distinct and represent two valid species of the genus *Gagata*.

Day (*loc. cit.*, 1877, p. 493) included Hamilton's *Pimelodus batasio*² in the genus *Gagata*, and as he had no specimen for study he seems to have been greatly influenced by Hamilton's statement to the effect that “ There is no slit under the throat. . . ” Cuvier and Valenciennes³ included this species under *Bagrus*, Blyth⁴ under *Batasio* and Günther⁵ under *Macrones*. We have examined several specimens of the species from the type-locality and find that Hamilton's statement with regard to a slit under the throat is not correct. In Hamilton's original drawing⁶ of the species the two nostrils of each side are shown as situated wide apart, which precludes its being a member of the Sisoridae. This species has been rightly assigned by Shaw and Sheb-

¹ Day, F., *Proc. Zool. Soc. London*, p. 309 (1869).

² Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh: 1822).

³ Cuvier, G. and Valenciennes, A., *Hist. Nat. Poisson XIV*, p. 425 (1839).

⁴ Blyth, E., *Journ., As. Soc. Bengal XXIX*, p. 150 (1860).

⁵ Günther, A., *Cat. Fish. Brit. Mus. V*, p. 83 (1864).

⁶ Day, F., *Fish. India*, pl. xcix, fig. 5 (1877); Hora, S. L., *Mem. Ind. Mus. IX*, pl. xxii, fig. 3 (1929).

beare¹ to the genus *Batasio* Blyth, which is dealt with in the next article of this series.

As regards the true systematic position of *Pimelodus tengana* Hamilton there is some difficulty. It has been included under the genus *Bagrus* by Cuvier and Valenciennes, *Batasio* by Blyth, *Macrones* by Günther and *Gagata* by Day. This species was collected by Hamilton in the Brahmaputra and in his original notes the description is dated "Gualpara, 29th July, 1808." To elucidate its systematic position attention may be directed to the following salient features as noted by Hamilton:—

1. There are eight barbels shorter than the head.
2. The anal fin possesses fourteen rays.
3. It is a small fish of about 3 inches in length.
4. The back is marked with many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail are also dotted, so that the edge of the last is black, and several spots are formed on the first.
5. Both openings of each nostril are circular, with a tendril between them.
6. Under the lower jaw there is no slit.

Though it is stated by Hamilton that the two openings of each nostril have a barbel between them, his figure shows that these openings are situated widely apart and that the posterior one is provided with a barbel at the anterior end. It would thus appear that the species cannot be referred to the Sisoridae, but belongs to the Bagridae. It seems to belong to the genus *Batasio* and is conspecific with Blyth's *B. affinis*. We shall elucidate further the systematic position of this species in our account of the fishes of the genus *Batasio*.

Hamilton's *P. nangra*, the type of Day's genus *Nangra*, differs from *Gagata gagata* and *G. cenia* in having longer barbels and deeply notched gill-membranes, though Hamilton in the description of this species also states "There is no slit under the throat." The bases of the mandibular barbels are not situated in a straight line. As indicated above, we do not regard these differences of generic value, especially as *Gagata itchkeea* (Sykes) is a form intermediate in characters between *Gagata* and *Nangra*.

In *Pimelodus viridescens*, Hamilton mentioned only six barbels; evidently he overlooked the minute nasal barbels. The most significant feature of this species is its greatly depressed head and anterior part of body. It is stated to possess a slit under the throat. From a careful study of Day's descriptions of *Nangra punctata* and *Nangra viridescens* and also from an examination of his drawings of the two species it seems probable that the two are identical, the latter being the juvenile form of the former. Two fresh specimens in our collection also confirm this view. In the nature of its gill-openings, *G. viridescens* agrees with *G. nangra*. Day recorded this species from Poona and one of us² also recorded it from the Deccan. Re-examination of the

¹ Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98 (1938).

² Hora, S. L., *Rec. Ind. Mus.* XXXIX, p. 19 (1937).

material has shown that the Deccan specimens are referable to *G. itchkeea* in which the isthmus is very narrow and the mandibular barbels are not situated in an absolute straight line.

The only extra-Indian species of *Gagata* is *G. schmidti* Volz from Sumatra. Its salient features are the depressed head, $1\frac{1}{2}$ times broader than high; the small eyes, longitudinal diameter being contained 13 times in length of head; the absence of fontanels; the dorsal spine being dentated along the front and hind borders; the very narrow isthmus, and its almost uniform gray brown colour.

The Indian species of the genus *Gagata* may be distinguished by the following key:—

Key to the Indian species of the genus Gagata Bleeker.

- I. Nasal barbels small or rudimentary, being almost as long as or considerably shorter than longitudinal diameter of eye.
 - A. Dorsal fin considerably longer than head; both dorsals, anal, pectoral and pelvic fins black distally.

[Gill-membranes united with a fairly broad isthmus; maxillary barbels slightly and mandibular barbels considerably shorter than head; bases of mandibular barbels close together and in a transverse row; median groove on head extending to end of occipital process]

G. gagata.
 - B. Dorsal fin considerably shorter than head; distal portions of fins not coloured black.
 1. Maxillary barbels longer than head.

[Gill-membranes united with a very narrow isthmus; mandibular barbels somewhat shorter than head; bases of inner mandibular barbels somewhat in advance of those of the outer; median groove on head extending as far as posterior border of orbit and followed by a small, median, oval fontanel]

G. itchkeea.
 2. Maxillary barbels considerably shorter than head.
 - a. Bases of mandibular barbels close together and in a transverse row. [Gill-membranes united with a narrow isthmus; width of head considerably less than its length in front of pectorals; median groove on head extending to base of occipital process]

G. cenia.
 - b. Bases of mandibular barbels set widely apart, and at different levels. [Gill-membranes united with each other and the isthmus; head almost as broad as its length in front of pectorals; median groove on head extending to base of occipital process]

G. viridescens.

- II. Nasal barbels almost as long or longer than head.
 [Bases of mandibular barbels set widely apart,
 and at different levels; gill-membranes united
 with each other across the isthmus; maxillary
 and outer mandibular barbels much longer than
 head; median groove on head extending to
 base of occipital process] *G. nangra.*

Gagata gagata (Hamilton).

Plate I, figs. 1, 2.

1822. *Pimelodus gagata*, Hamilton, *Fish. Ganges*, pp. 197, 379, pl. xxxix, fig. 65.
 1854. *Pimelodus gagata*, Bleeker, *Verh. Bat. Gen. XXV*, p. 58.
 1858. *Gagata gagata*, Bleeker, *Ichthyol. Archipel. Indici, Prodromus*, I, *Silurt.*,
 p. 206.
 1860. *Gagata gagata*, Blyth, *Journ. As. Soc. Bengal XXIX*, p. 151.
 1862. *Gagata typus*, Bleeker, *Atl. Ichthyol.* II, p. 7.
 1864. *Callomystax gagata*, Günther, *Cat. Fish. Brit. Mus.* V, p. 218.
 1869. *Gagata typus*, Day, *Proc. Zool. Soc. London*, p. 309.
 1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 4.
 1877. *Callomystax gagata*, Beavan, *Freshw. Fish. India*, p. 149.
 1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 208, fig. 75.

D. 1/6; A. 3-4/10-12; P. 1/9; V 1/5; C. 19.

Gagata gagata is a medium-sized, stoutly-built species in which the dorsal profile rises moderately to the commencement of the dorsal fin beyond which it slopes down gradually to the base of the caudal fin. The ventral profile is almost horizontal as far as the commencement of the pelvic fins and thereafter it rises gradually to the base of the caudal fin. The fish is compressed from side to side, more so in the posterior half; the dorsal surface forms a narrow ridge. The ventral surface in front of the pelvic fin is somewhat flattened.

The head is broadly pointed in front; its length is contained from 3.61 to 3.93 times in the standard length. The height of the head at the occiput is contained from 1.05 to 1.45 times and its width from 1.25 to 1.57 times in its length. The snout is prominent and globular; it is produced in front of the mouth for a short distance. The eyes are dorso-lateral in position and are situated nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 2.65 to 3.76 times in the length of the head, from 0.89 to 1.58 times in the length of the snout and from 0.65 to 1.20 times in the inter-orbital width. The two nostrils of each side are fairly prominent, close together and situated much nearer to the tip of the snout than to the eye. The dorsal surface of the head is covered with smooth skin but is marked with bony ridges. The median groove on the head commences from in front of the nostrils and is continued with slight variations to the end of the occipital process which misses the basal bone of the dorsal fin by a short distance. The occipital process is long and narrow, almost 4 to 5 times as long as broad at its base. The mouth is small and horizontal; it is bordered by thick and slightly fimbriated lips which are continuous at the angles of the mouth. There are patches of small, villiform teeth in the jaws. There are four pairs of barbels; the nasal barbels are small and thin and are rarely as long as the longitudinal diameter of eye. The maxillary barbels possess

stiff bony bases and membranous flaps along the inner side of the proximal one-third of their lengths. These barbels rarely exceed the length of the head. The two pairs of mandibular barbels have somewhat swollen bases which are arranged in a transverse row behind the lower lip; these barbels are shorter than half the length of the maxillary barbels. The gill-opening is restricted on the ventral surface; the distance between the two openings is contained from 0.55 to 0.92 times in the diameter of the eye.

The depth of the body is contained from 3.34 to 4.37 times in the standard length. The caudal peduncle is well formed; its least height is contained from 1.28 to 2.00 times in its length. Two oval patches of skin above the pectorals indicate the areas where the air-bladder comes directly in contact with the skin. The cubito-humeral processes are fairly well marked. The anal opening is situated nearer to the commencement of the caudal fin than to that of the pectorals. The urino-genital openings¹ are separate; in the female they are situated immediately behind the anus and form a slit-like aperture bordered by fleshy lips which project in the form of a short papilla-like structure distally. In the male the urinary opening is situated on a papilla behind the anus.

The dorsal fin is pointed and situated almost wholly in advance of the pelvic fins; it is longer than the head; its spine is long, pointed and almost as long as, slightly shorter or longer than the head. It is finely serrated along the distal one-third of the anterior border. The adipose fin is short, but well marked; its base is somewhat longer than that of the rayed dorsal. The pectoral fins are also pointed and are placed only slightly above the ventral surface; they do not extend to the base of the pelvic fins. The pectoral spine is strong and denticulated internally; its outer border is provided with a few teeth at the distal end. The pelvic fins extend considerably beyond the anal opening and their outer rays are pointed. The anal fin is of moderate length and the caudal fin is deeply forked with both the lobes pointed, the upper lobe is somewhat better developed than the lower.

The general colour of the body is opaque yellow verging to dull gray. The greater part of the pectorals, the distal halves of the dorsal, pelvic, and anal fins are conspicuously coloured black. The caudal fin is whitish. The colouration of the species is one of its most characteristic features.

Distribution.—Unfortunately a number of specimens of *Gagata gagata* in the collection of the Indian Museum do not bear locality labels, but it seems probable that the species is found in the Ganges, Brahmaputra and Irrawadi River systems. It is represented in the collection from Allahabad, Calcutta, Khulna and Prome. It is said to attain a foot in length.

¹ Urino-genital structures similar to those described here are erroneously termed by Mookerjee, Mazumdar and Das Gupta as "vagina" and "penis" (*Ind. Journ. Vet. Sci. Animal Husb.* X, p. 295, 1940). The authors seem to have ignored the fact that in teleosts the "urinary opening may be separate or confluent with that of the genital ducts and is frequently placed on a more or less prominent papilla (*papilla urogenitalis*). If separate, the urinary opening is behind the genital; and if a papilla is developed, its extremity is perforated by the urethra, the genital opening being situated near the base" (Günther, *Introduction to the Study of Fishes*, p. 156, 1880).

Measurements in millimetres of the specimens of Gagata gagata (Ham.)

	Allahabad.	Hooghli R., Bengal.				Pusar R., Khulna, Bengal.	Prome, Burma.	Locality unknown.						
Standard length	102.0	77.0	79.0	94.0	97.5	83.5	118.0	81.5	90.0	90.5	92.0	120.0	139.0	143.0
Length of head ..	26.0	20.0	20.5	24.5	26.0	22.0	30.5	21.5	23.5	23.0	23.5	32.0	38.5	38.0
Height of head at occiput ..	20.5	16.0	19.5	21.0	20.5	17.0	21.0	16.5	19.0	19.5	17.0	26.0	27.5	28.5
Width of head ..	18.5	15.5	13.0	19.5	18.5	17.5	19.5	17.0	16.5	17.5	16.0	23.0	25.0	25.0
Length of snout ..	10.0	8.0	8.5	9.5	10.5	8.5	12.5	8.5	10.0	10.0	9.5	13.5	13.0	16.0
Diameter of eye ..	8.5	6.5	5.0	8.0	8.0	7.0	10.5	7.5	7.0	7.5	6.5	8.5	14.5	12.0
Interorbital width	8.0	7.0	6.0	7.5	9.0	8.0	8.0	6.5	8.0	7.0	7.0	9.5	9.5	9.5
Depth of body ..	28.5	23.0	21.0	26.0	26.5	22.5	27.0	21.5	26.5	25.5	24.5	33.0	36.0	33.5
Length of caudal peduncle	17.0	9.0	11.0	14.0	13.0	13.0	18.5	10.5	12.0	13.0	13.5	16.0	21.5	23.0
Least height of caudal peduncle.	8.5	7.0	7.5	7.5	8.5	7.5	11.0	7.0	8.0	8.0	8.5	11.0	13.0	11.5
Longest ray of dorsal	33.5	25.0	23.5	31.5	37.5	27.5	29.0	28.0	30.0	35.0	34.5	40.5	42.0	38.5
Length of dorsal spine	27.5	20.0	19.0	27.0	29.0	23.0	25.0	23.5	24.0	29.0	25.0	33.5	35.5	D.
Length of pectoral	28.5	22.0	21.5	28.0	29.5	22.0	30.5	22.0	14.0	27.0	28.0	32.5	43.5	42.0
Length of pectoral spine	25.5	19.0	19.0	24.5	26.5	21.5	28.0	21.0	22.0	25.0	24.5	30.5	39.0	37.0
Length of ventral	18.0	13.0	13.5	18.0	18.5	15.5	18.0	14.0	14.5	17.5	15.5	21.0	26.5	25.5
Longest ray of anal	21.0	D.	12.0	18.5	19.0	D.	18.5	15.0	17.0	21.0	17.0	D.	30.0	D.
Length of base of anal	16.0	11.0	11.0	13.5	13.5	11.5	17.0	12.0	14.0	15.0	14.5	17.5	19.5	20.0
Length of base of adipose dorsal.	16.5	11.5	10.5	14.5	13.0	8.5	15.0	12.5	10.5	10.0	14.0	14.0	16.5	16.0

Gagata itchkeea (Sykes).

Plate I, figs. 3, 4.

1840. *Phractocephalus itchkeea*, Sykes, *Trans. Zool. Soc. London* II, p. 373, pl. lxvii, fig. 1.
1849. *Pimelodus itchkeea*, Jerdon, *Madras Journ. Litt. Sci.* XV, p. 341.
1854. *Bagrus itchkeea*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1864. *Macrones itchkeea*, *Cat. Fish. Brit. Mus.* V, p. 84.
1876. *Hemipimelodus itchkeea*, Day, *Journ. Linn. Soc. London, Zoology* XII, p. 571.
1877. *Gagata itchkeea*, Day, *Fish. India*, p. 492, pl. cxv, fig. 6.
1889. *Gagata itchkeea*, Day, *Faun. Brit. Ind., Fish* I, p. 209.
1937. *Nangra viridescens*, Hora (*nec* Hamilton), *Rec. Ind. Mus.* XXXIX, p. 19.
1937. *Nangra viridescens*, Hora & Misra (*nec* Hamilton), *Journ. Bombay Nat. Hist. Soc.* XXXIX, p. 511; *ibid.* XL, p. 23, 1938.

D. 2/6; A. 2-3/9-10; P. 1/8; V 1/5; C. 18-19.

Gagata itchkeea is a small, almost cylindrical fish in which both the dorsal and the ventral profiles are slightly arched. The body is only slightly compressed anteriorly, but in the region behind the pelvic fins the compression is more marked. The ventral surface in front of the pelvic fins is only slightly flattened and, in consequence, the pectoral fins are placed at a considerably higher level than the ventral surface.

The head is short, globular and rounded anteriorly; its length is contained from 3.57 to 4.05 times in the standard length. The height of the head at the occiput is contained from 1.25 to 1.50 times and its width from 1.16 to 1.50 times in its length. The snout is so much rounded that one gets the impression of a pug-headed fish and the nostrils are almost directed anteriorly; it projects beyond the mouth for a short distance. The eyes are large and dorso-lateral in position; they are not visible from the ventral surface. The diameter of the eye is contained from 2.20 to 2.75 times in the length of the head, from 0.60 to 1.00 times in the length of the snout and from 0.63 to 0.87 times in the interorbital distance. The nostrils are large and well formed and are situated almost midway between the tip of the snout and the eyes. The median groove on the head extends from between the nostrils to the base of the occipital process, but anteriorly there are lodged in it one large and one small fontanel. After the second fontanel the groove is very shallow and hardly perceptible posteriorly. The edges of the groove are slightly raised to form longitudinal ridges. The occipital process is long and narrow, its length is about 3 times its width at the base; it is separated from the basal bone of the dorsal fin by a short distance. The mouth is small, inferior and horizontal; it is bordered by fleshy lips which are continuous and free at the angles of the mouth. The teeth are small, villiform, and hardly perceptible. There are four pairs of barbels; the nasal barbels are small and considerably shorter than the diameter of the eye; the maxillary barbels are longer than the head and their basal parts stiff; the membrane in

their axils is little developed ; the two pairs of mandibular barbels are almost equal and are as long as the head behind the anterior border of the orbit. The bases of the mandibular barbels are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are attached to the isthmus but the gill-openings are separated by a distance which is generally less than one-fifth of the diameter of the eye.

The depth of the body is contained from 4.00 to 5.41 times in the standard length. The least height of the caudal peduncle is contained from 1.14 to 1.85 times in its length. The portion of the body where the air-bladder comes in close contact with the skin is not well marked externally, but the cubito-humeral processes are fairly distinct. The anus is followed by a small urino-genital papilla.

The dorsal fin is situated in advance of the pelvic fins ; it is generally shorter than the head. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is small, but well developed. The pectoral fin is pointed and almost reaches the base of the pelvic fins ; its spine is strong and crenulated along the outer border but serrated for two-thirds of its length internally. The pelvic fins extend beyond the anal opening, but are separated from the anal fin by a short distance. The anal fin is short like the dorsal. The caudal fin is deeply forked ; both the lobes are pointed, the upper being somewhat longer.

Sykes noted that the colour of the fish is "yellowish glossy silver, inclining to greenish on the back, and silvery on the belly ; marked with dark bluish brown broad spots along the back, head, and at the base of the rays of the tail" Day remarked that the colour is "yellowish-bronze, becoming silvery on the sides and abdomen : some dark blotches along the back descending to half way down the sides. A black blotch on either lobe of the caudal, and another on the dorsal fin" In the specimens examined by us the colour varies only slightly from the earlier descriptions, and the saddle-shaped black bands on the body though only faintly marked in some are fairly conspicuous in others.

Distribution.—As stated by Day, *G. itchkeea* is found only in the rivers of the Deccan. In the collection of the Indian Museum, this species is represented from Deolali, Poona, Satara (Bombay Presidency) and from the Cauvery in the Coorg State.

Remarks.—*G. itchkeea* is intermediate between *G. gagata* and *G. nangra* in several respects and on account of its wide gill-openings and the disposition of the bases of the mandibular barbels is liable to be referred to the genus *Nangra*. Its relatively longer barbels also show its affinity to *G. nangra*. Sykes considered it a close ally of Hamilton's *Pimelodus tengana*, which we have referred to the genus *Batasio* Blyth. *G. itchkeea* rarely exceeds three inches in length and seems to be very common in the waterways at Poona.

Measurements in millimetres of the specimens of Gagata itchkea (Sykes).

	Deolali.	Poona.					Satara.		Cgorg.	Bombay market.	Meema.
Standard length	38.0	38.5	40.5	42.5	46.0	46.5	47.0	49.0	50.0	41.0	40.0
Length of head	10.0	10.5	10.0	11.0	12.5	11.5	13.0	13.0	14.0	11.0	10.5
Height of head at occiput	7.0	7.0	8.0	7.5	8.5	9.0	9.0	9.5	10.5	7.5	7.5
Width of head	7.0	7.0	8.0	8.0	8.5	9.5	9.0	10.5	12.0	9.0	7.5
Length of snout	3.5	3.5	3.0	4.0	4.0	3.0	4.5	5.0	4.0	4.0	3.5
Diameter of eye	4.5	4.5	4.5	4.0	5.5	5.0	5.0	5.0	6.0	5.0	4.5
Interorbital width	3.0	3.0	3.0	3.5	3.5	3.5	3.5	4.0	4.0	3.5	3.0
Depth of body	8.0	9.5	9.0	10.0	8.5	11.0	11.5	11.0	12.5	9.0	8.0
Length of caudal peduncle	4.0	5.5	6.5	7.0	5.0	7.0	7.0	7.5	8.5	5.0	4.0
Least height of caudal peduncle ..	3.0	3.5	3.5	4.0	4.0	4.0	4.5	5.0	5.0	4.0	3.5
Longest ray of dorsal ..	8.5	9.0	9.0	11.0	11.0	10.5	11.8	12.0	13.0	10.5	10.5
Length of dorsal spine	6.0	7.5	8.0	9.0	9.0	8.5	9.8	10.4	9.5	8.0	8.0
Length of pectoral ..	11.0	11.0	10.5	12.0	12.0	12.5	14.0	13.5	15.5	13.0	13.0
Length of pectoral spine	9.0	8.0	9.5	10.0	10.5	11.5	12.5	12.0	14.0	11.0	11.5
Length of ventral	7.0	6.0	6.5	8.0	7.5	7.0	8.0	8.5	9.5	7.5	6.5
Longest ray of anal ..	8.0	7.5	8.0	7.0	8.5	9.0	10.0	10.5	11.5	8.0	D.
Length of base of anal..	6.5	5.5	6.5	6.8	5.5	6.0	7.0	8.5	8.0	6.5	6.0
Length of base of adipose dorsal ..	8.0	5.0	5.5	6.5	5.0	6.0	7.0	7.0	7.5	5.5	6.0
Width of isthmus	0.5	0.9	1.0	0.8	1.0	0.95	1.0	1.0	0.3	0.9	1.5

Gagata cenia (Hamilton).

Plate I, figs. 5, 6.

1822. *Pimelodus cenia*, Hamilton, *Fish. Ganges*, pp. 174, 376, pl. xxxi, fig. 57.
 1854. *Pimelodus cenia*, Blecker, *Verh. Bat. Gen.* XXV, p. 58.
 1869. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 308.
 1871. *Hemipimelodus cenia*, Day, *Proc. Zool. Soc. London*, p. 288.
 1877. *Gagata cenia*, Day (in part), *Fish. India*, p. 492, pl. cxv, fig. 5.
 1889. *Gagata cenia*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 208.
 1890. *Gagata cenia*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Geneva* (2) IX, p. 121.
 1921. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XXII, p. 182.
 1938. *Gagata cenia*, Hora, *Rec. Ind. Mus.* XL, p. 180, fig. 6.
 1939. *Gagata cenia*, Das, *Rec. Ind. Mus.* XLI, p. 448.

D. 2/6 ; A. 2-3/10-12 ; P. 1/7-9 ; V 1/5 ; C. 17-19.

Gagata cenia is a comparatively small and slender fish, in which the dorsal and the ventral profiles are slightly arched. The body, however, becomes considerably narrow in the caudal region. The ventral surface in front of the pelvic fins is flattened and horizontal. The dorsal surface is somewhat rounded and the head and the body, except in the tail region, are moderately compressed.

The head is flattened on the ventral surface and more or less rounded anteriorly ; its length is contained from 3.62 to 4.47 times in the standard length. The height of the head at the occiput is contained from 1.29 to 1.87 times, and its width from 1.40 to 2.00 times in its length. The snout is prominent, globular and projects beyond the mouth for a considerable distance. The eyes are large and dorso-lateral in position ; they are not visible from the ventral surface. They are situated either in the middle of the head or slightly nearer to the posterior margin of the operculum than to the tip of the snout. The diameter of the eye is contained from 1.87 to 3.41 times in the length of the head, from 0.62 to 1.33 times in the length of the snout and from 0.50 to 0.85 times in the interorbital width. The nostrils are situated almost midway between the eye and the tip of the snout or slightly nearer to the former than to the latter. The head is covered with smooth skin, but its dorsal surface is marked with two longitudinal bony ridges and the supra-orbital bones are also slightly raised above the surface. The median groove on the head commences from in front of the nostrils and after a slight interruption is continued to a point in front of the base of the occipital process. The occipital process is about three times as long as broad at its base and misses the basal bone of the dorsal fin by a short distance. The mouth is small, horizontal and crescentic ; it is bordered by fleshy lips which are free and continuous at the angles of the mouth. The median portion of the upper lip is swollen and plicated ; it forms a prominent fold in front of the mouth. There are small and villiform teeth in the jaws. There are four pairs of barbels ; the nasal barbels are so minute that they are likely to be overlooked ; the basal portions of the maxillary barbels are stiff and there is a thick membrane in their axils ; they are slightly shorter than the head ; the mandibular barbels are considerably shorter and their bases are situated in a transverse series behind the lower lip. In a very large number of

specimens there are two finger-like processes situated in the mid-ventral line between the bases of the inner mandibular barbels. Sometimes these structures are represented by nodules attached to the posterior lips, while in certain specimens they are entirely absent. These structures, like the barbels, are probably tactile in function. The gill-openings are somewhat restricted on the ventral surface by a narrow isthmus; the distance between the gill-openings is contained from 0.15 to 0.63 times in the diameter of the eye.

The depth of the body is contained from 4.0 to 6.0 times in the standard length. The least height of the caudal peduncle is contained from 1.27 to 2.14 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally and the cubito-humeral processes are not so prominent. The urino-genital openings are similar to those described above for *Gagata gagata* (*vide supra*, p. 16).

The dorsal fin is obliquely truncate and its base is situated wholly in advance of the pelvic fins; it is usually shorter than the head, but in rare cases it may be just as long as the head. The dorsal spine is a short, strong prickle which is smooth along the posterior border but is finely serrated along the anterior border, especially along the distal portion. The adipose dorsal is short but well marked. Generally the pectoral fin is shorter than the head, but sometimes it is equal to or even slightly longer than the head; they are separated from the pelvic fins by a considerable distance. The pectoral spine is denticulated in the middle along its inner border and serrated along the distal half of the outer border. The pelvic fins reach as far as or extend slightly beyond the anal opening. The anal fin is short and low. The caudal fin is deeply forked and both the lobes are sharply pointed; the upper lobe is somewhat longer than the lower.

Hamilton noted that "The general colour is silver, with some dusky on the back, and the bars descending to the lateral lines. The end of the tail is black; and the first fin of the back, and that of the tail, are stained with the same colour. The eyes are silver-coloured." He had also noted that the back was marked with four transverse bars. Day, who regarded this species as comprising of young individuals only, stated that "The young are of a yellowish bronze colour, becoming silvery on the abdomen: they have three dark bands over the head and four more over the back, descending as low as the lateral-line. Caudal with a semi-lunar black band, or a black blotch on each lobe: a dark mark across the dorsal fin." The specimens in the collection of the Indian Museum vary slightly as regards colouration but in general agree closely with Day's description.

Distribution.—Hamilton described this species from the northern parts of Bengal, but as Day had confused *Gagata gagata* with *G. cenia*, it is not possible to accept the range of distribution of this species given by him. In the collection of the Indian Museum, it is represented from the Punjab, Delhi, Nepal, Bihar, Orissa, Bengal, and Assam (including Chindwin Drainage System). It rarely exceeds six inches in length and was originally described by Hamilton from specimens about three inches in length.

Measurements in millimetres of specimens of Gagata cenia (Ham.).

	Manipur, Assam.					Chutri Gouri in Terai, Nepal.		Calcutta and Nawabgunge, Bengal.			Barhat and Damodar River, Bihar.			Orissa.	Delhi.		Chenab Canal, Punjab.
Standard length	56.5	59.5	65.0	72.5	84.5	59.0	77.0	63.5	38.0	42.5	59.0	63.0	42.0	55.0	66.0	78.5	52.0
Length of head	14.0	15.0	15.5	18.0	23.0	16.2	20.5	17.5	8.5	11.0	16.0	17.0	11.5	15.0	18.2	21.5	14.0
Height of head at occiput	10.0	10.0	12.0	11.5	13.5	10.0	12.5	10.0	5.5	6.0	8.5	9.5	6.5	8.5	11.0	12.0	7.5
Width of head ..	8.5	9.0	11.0	10.5	13.0	9.0	11.5	9.2	5.5	6.0	8.5	9.0	6.0	7.5	9.2	11.2	8.0
Length of snout ..	5.5	5.0	5.5	7.0	8.0	5.5	8.0	6.0	3.0	3.5	6.0	7.0	4.5	5.0	7.2	8.0	6.0
Diameter of eye ..	6.5	8.0	7.0	7.5	7.0	5.5	6.0	5.5	3.5	4.0	5.5	7.0	4.0	6.0	6.5	7.0	5.0
Interorbital width	4.0	4.0	4.0	5.5	6.0	4.0	5.0	4.0	2.5	2.0	3.5	4.0	2.8	3.5	3.5	5.0	3.0
Depth of body ..	11.0	12.0	14.0	14.0	17.0	10.0	13.0	12.0	6.5	8.5	10.5	10.5	10.5	9.5	11.4	13.5	10.0
Length of caudal peduncle ..	8.0	8.5	9.0	8.5	10.0	8.0	11.0	7.5	5.0	6.0	8.0	7.0	7.0	7.5	9.0	10.0	6.5
Least height of caudal peduncle	5.0	5.0	6.0	6.5	7.0	5.0	5.5	5.0	3.5	4.5	4.5	5.5	4.0	3.5	5.5	6.5	3.5
Longest ray of dorsal ..	12.5	14.0	15.0	14.5	22.5	14.0	17.0	13.0	8.5	11.0	13.0	13.5	10.5	11.5	13.5	16.0	11.0
Length of dorsal spine	11.0	11.0	12.0	D.	15.5	11.0	15.0	12.0	7.5	9.5	11.5	12.0	9.5	9.5	13.0	14.5	10.0
Length of pectoral	15.0	15.0	16.0	D.	20.5	13.0	18.0	13.0	8.5	12.5	12.0	14.5	10.0	11.5	15.5	17.5	11.5
Length of pectoral spine ..	12.0	13.5	14.0	D.	18.0	11.5	17.5	12.5	8.0	10.0	13.0	14.0	9.5	11.0	14.0	17.0	10.5
Length of ventral	8.5	10.0	11.0	12.5	14.0	9.0	11.0	9.5	6.0	7.0	12.5	9.5	6.0	7.5	10.5	12.0	7.5
Longest ray of anal	10.5	10.5	12.0	14.0	14.5	9.5	10.5	9.5	9.0	8.5	10.0	10.0	7.0	7.0	11.0	12.0	8.0
Length of base of anal	9.0	9.0	11.0	11.5	13.0	8.5	11.0	8.5	9.5	9.0	9.0	9.5	6.0	8.5	9.0	9.5	8.5
Length of base of adipose dorsal.	9.0	8.5	8.5	12.0	10.5	8.0	10.0	6.5	4.5	6.0	7.0	8.5	6.5	6.5	8.5	10.5	8.0
Width of isthmus	1.0	1.2	D.	1.0	3.0	3.5	3.5	3.0	0.8	1.0	1.0	2.5	1.5	3.0	2.5	3.0	2.0

Gagata viridescens (Hamilton).

Plate I, figs. 7, 8.

1822. *Pimelodus viridescens*, Hamilton, *Fish. Ganges*, pp. 173, 376, pl. x, fig. 56.
 1854. *Pimelodus viridescens*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.
 1877. *Nangra punctata*, Day, *Fish. India*, p. 494, pl. cxv, fig. 8.
 1877. *Nangra viridescens*, Day, *Fish. India*, p. 494, pl. cxv, fig. 7.
 1889. *Nangra punctata*, Day, *Faun. Brit. Ind. Fish.* I, p. 212, fig. 76.
 1889. *Nangra viridescens*, Day, *Faun. Brit. Ind. Fish.* I, p. 212.

D. 1/6 ; A. 2/9 ; P. 1/8 ; V 1/5 ; C. 21.

In *Gagata viridescens* the head and the body in front of the anal fin is greatly depressed and the ventral surface is flattened. The tail is somewhat compressed and subcylindrical. The dorsal profile is slightly arched, while the ventral profile is straight and horizontal in front of the anal fin.

The head is large and broad, it is covered with minute spine-like structures ; its length is contained from 3.00 to 3.18 times in the standard length. The height of the head is contained from 1.63 to 1.78 times and its width from 1.27 to 1.31 times in its length. The snout is broad and rounded in front ; it projects beyond the mouth for a considerable distance. The eyes are of moderate size and dorso-lateral in position ; they are not visible from the ventral surface. The eyes are relatively larger in young specimens and are situated almost in the middle of the length of the head ; their diameter is contained from 3.50 to 4.16 times in the length of the head and from 1.37 to 1.75 times in the length of the snout. The interorbital distance is equal to the diameter of the eye. The nostrils are well-formed, rounded apertures ; they are situated much nearer to the tip of the snout than to the eyes. The median groove on the head is pointed both anteriorly and posteriorly, and extends from in front of the nostrils to the base of the occipital process ; behind the level of the eyes there is a slight ridge across the groove. The occipital process is long and club-shaped ; its width at the base is contained about 4 times in its length ; it misses the basal bone of the dorsal fin by a short distance. The mouth is wide, inferior and horizontal ; it is provided with fleshy lips which are continuous at the angles of the mouth. The anterior lip is papillated, and both the lips at the angles of the mouth are plicated. The posterior lip is also somewhat roughened along its middle part. The teeth are small and villiform ; they are arranged in bands in the jaws. There are four pairs of barbels ; the nasals are minute or rudimentary and are liable to be overlooked altogether ; the maxillary barbels are considerably shorter than the head, are provided with stiff basal portions which lie in lateral grooves ; the mandibular barbels are much shorter and their bases are situated wide apart, those of the inner pair are considerably in advance of those of the outer pair. The gill-openings are wide and extensive ; the gill-membranes are confluent with each other and with the isthmus in the mid-ventral line. The width of the isthmus is very narrow.

The depth of the body is contained from 4.45 to 4.54 times in the standard length. The least height of the caudal peduncle is contained

from 1.63 to 1.71 times in its length. The portion of the body where the air-bladder comes directly in contact with the skin is not well marked externally. The cubito-humeral processes are well developed. The external urino-genital organs are similar to those described in *G. gagata* (*vide supra*, p. 16).

The dorsal fin is short and low, and is situated wholly in front of the pelvics; it is considerably shorter than the head and is provided with a small, strong spine, which is smooth along both the borders. The adipose dorsal is short, but well marked; the length of its base is almost equal to that of the rayed dorsal. The paired fins are horizontally placed; the pectorals are shorter than the head and provided with a very strong spine which is smooth along the outer border, but is strongly denticulated internally. The pectorals are separated from the ventrals by a considerable distance. The pelvics are small and pointed and extend beyond the anal opening. The caudal fin is deeply forked, with both the lobes pointed and subequal.

Hamilton stated that in his *Pimelodus viridescens* "The sides are silver coloured, the belly livid, and the fins of the back and tail spotted." The back is noted to be "reddish-brown, crossed by three green bars; and with opaque spotless sides" Day described the colouration of his *Nangra punctata* as follows: "coppery, glossed with gold on the sides: a black blotch on occiput, and three or four along the back descending half way down the sides. A black band on dorsal, and some black markings on the caudal." In his *N. viridescens*, which seems to represent young specimens, the colour is "glossy greenish-brown on the back, with two very light green bands passing one from the base of either dorsal fin to the middle of the depth of the body. A dark band on the dorsal fin and spots on either lobe of the caudal" In a young specimen, 44.5 mm. in standard length, besides the two short bands mentioned by Day, there are two other, one obliquely passing through the posterior part of the head and another on the back in front of the base of the caudal fin. The colouration of the larger specimen corresponds fairly closely with that of Day's *N. punctata*.

Distribution.—Hamilton described this species from the rivers of the northern parts of Bengal, but Day noted "Rivers of Northern Bengal, not uncommon in the Jumna at Delhi, and also found at Poona in the Deccan" The two specimens we have referred to *G. viridescens* are from Bengal and Assam respectively and we doubt whether the range of this species extends to the Deccan.

Measurements in millimetres.

	Tezpur, Assam.	Barakar, Santal Parganas.
Standard length	75.0	44.5
Length of head ..	25.0	14.0
Height of head at occiput	14.0	8.5
Width of head ..	19.0	11.0
Length of snout ..	10.5	5.5
Diameter of eye	6.0	4.0
Interorbital width	6.0	4.0
Depth of body	16.5	10.0
Length of caudal peduncle ..	9.0	6.0

Measurements in millimetres.

	Tezpur, Assam.	Barakar, Santal Parganas.
Least height of caudal peduncle ..	5.5	3.5
Longest ray of dorsal ..	15.5	8.0
Length of dorsal spine ..	9.5	6.5
Length of pectoral ..	18.0	12.5
Length of pectoral spine ..	16.0	11.0
Length of ventral ..	12.0	7.0
Longest ray of anal ..	14.5	8.5
Length of base of anal	9.0	6.5
Length of base of adipose dorsal	9.5	6.5

Gagata nangra (Hamilton).

Plate I, figs. 9, 10.

1822. *Pimelodus nangra*, Hamilton, *Fish. Ganges*, pp. 193, 378, pl. xi, fig. 63.1854. *Pimelodus nangra*, Bleeker, *Verh. Bat. Gen.* XXV, p. 58.1871. *Macrones nangra*, Day, *Proc. Zool. Soc. London*, p. 288.1877. *Nangra buchanani*, Day, *Fish. India*, p. 494, pl. cxiii, fig. 3.1889. *Nangra buchanani*, Day, *Faun. Brit. Ind. Fish.* I, p. 211.

D. 2/9-10 ; A. 3/10 ; P. 1/9 ; V 1/5 ; C. 16-17.

Gagata nangra is a small and slender species in which the dorsal profile is slightly arched, while the ventral profile is horizontal in front of the pelvic fins and thence rises gradually to the tail. The body is compressed from side to side, more so in the tail region. The ventral surface of the head and the anterior part of the body are flattened.

The head is sharp, long and oval ; its length is contained from 3.83 to 4.18 times in the standard length. The height of the head is contained 2.0 times and its width from 1.06 to 1.50 times in its length. The snout is long and pointed, and projects in front of the mouth for a considerable distance. The eyes are relatively small and dorso-lateral in position ; they are not visible from the ventral surface. The diameter of the eye is contained from 5.38 to 6.00 times in the length of the head, 1.20 times in the length of the snout and from 1.20 to 1.33 times in the interorbital width. The two nostrils of each side are well marked and are placed nearer the tip of the snout than the eye. The median groove on the head is broad and extends from between the nostrils to the base of the occipital process ; the lateral edges of the groove are raised into slightly elevated longitudinal ridges. At the sides of the groove in the posterior region of the head there are two pairs of fontanels. The occipital process is broad and long ; it is almost twice as long as broad at the base and almost extends to the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal ; its width is almost equal to the length of the snout. The lips are visible as definite structures only near the angles of the mouth. The teeth are minute and in the upper jaw are situated outside the mouth. There are four pairs of barbels ; the nasal barbels are almost as long as the head ; the maxillary barbels are provided with stiff basal parts and extend to the anal fin or beyond ; the outer mandibular barbels are more than one and a half times as long as head while the inner pair is equal to the head behind the nostrils. The bases of the inner pair of mandibular barbels are situated in front of those of the outer pair. The gill-openings are wide

and on the ventral surface extend anteriorly to the median line; the gill-membranes are united with each other.

The depth of the body is contained from 6.90 to 8.37 times in the standard length. The least height of the caudal peduncle is contained from 2.20 to 2.75 times in its length. The portion of the body where the air-bladder comes in contact with the skin is not well marked externally. The cubito-humeral processes are, however, well developed.

The commencement of the dorsal fin is situated well in advance of that of the pelvics, but its base extend over the pelvic fins; its longest ray is greater than the head but the spine is somewhat shorter. The dorsal spine is a strong prickle which is smooth along both the edges. The adipose dorsal is short but well marked. The paired fins are horizontally placed, they are somewhat shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins are long and pointed; they extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the colours of *Gagata nangra* "are rather agreeable, being silver, with some green on the back, and a faint brown streak across the foremost back fin, and another across the fin of the tail" According to Day, the colour is "muddy, with three indistinct vertical greenish half bands" In the specimens examined by us, there is a short, faint longitudinal band below the base of the dorsal fin and another along the lateral line. There is a vertical bar at the base of the caudal fin and the dorsal surface of the head is dusky.

Distribution.—Hamilton found this species in the Kosi river, but Day extended its range to the Ganges, Jumna and Indus. The two specimens of *G. nangra* examined by us were collected from the river Hooghly at Nawabgunj.

This species can be readily distinguished by its longer barbels, pointed snout and extensive gill-openings.

Measurements in millimetres.

Standard length ..	..	33.5	34.5
Length of head ..		8.0	9.0
Height of head at occiput ..		4.0	4.5
Width of head ..		7.5	6.0
Length of snout ..		1.8	1.8
Diameter of eye		1.5	1.5
Interorbital width		1.8	2.0
Depth of body		4.0	5.0
Length of caudal peduncle		5.5	5.5
Least height of caudal peduncle	..	2.0	2.5
Longest ray of dorsal	..	9.0	10.0
Length of dorsal spine	..	7.0	8.0
Length of pectoral		6.8	8.0
Length of pectoral spine	..	5.2	6.5
Length of ventral		6.0	6.8
Longest ray of anal	.. ..	7.4	9.5
Length of base of anal	..	5.0	5.0
Length of base of adipose dorsal		5.5	7.0

X. FISHES OF THE GENUS *Batasio* BLYTH.

In the preceding article of this series, attention is directed to the fact that considerable confusion prevails regarding the taxonomic validity and the generic limits of *Batasio* Blyth, and reference has been made to the more salient features by which it can be distinguished from the superficially allied genus *Gagata*. In this article we give a detailed historical and taxonomic account of the genus, and descriptions of the species which we assign to it. A new species of *Batasio* has been discovered from Travancore, S. India, and the range of one of the Indian species, *B. tengana*, has recently been extended by Hora and Gupta¹ to the Malay Peninsula. These new records of the distribution of the genus from such widely separated localities are very significant from a zoogeographical point of view and lend considerable support to the hypothesis advanced by one of us² that the similarity in the fish-fauna of the Malay Region and of South India is due to the migration of the southern Chinese fishes to both the regions along mountain ranges at a time when the geographical features of these countries were different from what they are to-day. The migration of *Batasio* from Burma and Assam to Travancore was probably along the old Satpura trend of mountains as far as the Western Ghats and thence along the Ghats to the south of the Peninsula.

Batasio Blyth.

1860. *Batasio*, Blyth, *Journ. As. Soc., Bengal* XXIX, p. 149.

1862. ? *Batasio*, Bleeker, *Atl. Ichthyol.* II, p. 9.

1863. ? *Batasio*, Bleeker, *Ned. Tijds. Dierk.* I, p. 94.

1921. *Macronoides*, Hora, *Rec. Ind. Mus.* XXII, p. 179 (1921).

In 1860, Blyth³ established the genus *Batasio* to accommodate a group of Bagroid fishes and characterised it as follows:—

“A Bagroid form well worthy of distinction; comprising a number of small species with round and prominent muzzle, and the contracted mouth opening from below: with eight, or sometimes (?) six, cirri, which are very short, the maxillary cirri scarcely passing the eye in some. Palatal band of teeth continuous with the mass of maxillary teeth, or separated only by a slight groove. Rest as in *Bagrus* (*verus*).

“Type. *B. Buchanani*, nobis; *Pimelodus batasio*, H. B.”

Blyth did not examine any specimen of Hamilton's⁴ *Pimelodus batasio*, but described a new species, *B. affinis*, from Tenasserim. He observed that:—

“To the same type, but with shorter adipose dorsal, appertain the *tengana*, *chandamara* and *rama* of Buchanan Hamilton. *B. chandamara* is referred to *Silundia* by M. Valenciennes, and is described by Hamilton to have only two cirri; but his unpublished figure represents six cirri distinctly, and in all this group the minute cirri are discernible with difficulty and are extremely liable to be overlooked. To *Bagrus capenses* of Sir A. Smith's 'Illustrations of S. African Zoology' would appear also to be referable to this particular division.”

Bleeker⁵ considered *Batasio* a doubtful genus, but assigned it to the phalanx *Bagrichthyes* and stirps Bagrini. Günther⁶ evidently regarded

¹ Hora, S. L. and Gupta, J. C., *Bull. Raffles Mus. Singapore*, No. 17 (1941).

² Hora, S. L., *Rec. Ind. Mus.* XXXIX, pp. 255, 256 (1937); *Proc. Nat. Inst. Sci. India* IV, p. 405 (1938).

³ Blyth, E., *Journ. As. Soc. Bengal* XXIX, pp. 149, 150 (1860).

⁴ Hamilton, F., *Fish. Ganges*, p. 179 (Edinburgh, 1822).

⁵ Bleeker, P., *Ned. Tijds. Dierk.* I, p. 94 (1863).

⁶ Günther, A., *Cat. Fish. Brit. Mus.* V, p. 83 (1864).

it as a synonym of *Macrones*, for he described both *Pimelodus batasio* Ham. and *Batasio affinis* Blyth in this genus. Day¹ included it under *Gagata* and remarked in a footnote as follows :—

“Genus *Batasio*, Blyth, is said to comprise fishes with the barbels shorter than the head and teeth on the palate, examples : *Pimelodus batasio*, H. B. (the author merely says of the teeth, that those ‘in both jaws are crowded’), *P. tengana*, H. B., *B. affinis*, Blyth, *P. rama*, H. B. The two first probably belong to genus *Gagata*, the third to *Macrones*, and the last two to *Liocassis*.”

Vinciguerra² discussed the systematic position of *Batasio* in regard to *Macrones* and other allied Bagrid genera, but did not consider it distinct from *Macrones*. He described a new species *M. dayi* from Meetan and Toungoo which is stated to be closely allied to *Batasio affinis* Blyth.

Jordan in his ‘Genera of Fishes’ (p. 294) stated that *Batasio* Blyth replaces *Gagata* Bleeker. In view of the confused taxonomic position of *Batasio*, one of us (S. L. H.) did not realize its generic limits when he created the subgenus *Macronoides*³ for *Macrones affinis* (Blyth), *M. dayi* Vinciguerra and *M. marianiensis* Chaudhuri.⁴ *Macronoides* was characterised as follows :—

“This new subgenus is proposed for species which differ from typical *Macrones* in the possession of a distinct ventral mouth bordered by fringed lips ; in having short barbels not exceeding the length of the head ; in the mandibular pairs of barbels being disposed in a transverse row across the mandible and in the possession of open pores on the ventral surface of the head just behind the mouth. In general facies the fish of this subgenus show a remarkable resemblance to those of the genus *Gagata*, from which, however, they are easily distinguished by the crescentic band of teeth and a free air-bladder in the abdominal cavity.”

In examining the collection made by Messrs. G. E. Shaw and E. O. Shebbeare from the Terai and Duars, one of us (S. L. H.) found representatives of Hamilton’s little known species—*Pimelodus batasio*—and found it to belong to his genus *Macronoides*. He, therefore, suggested to Shaw & Shebbeare⁵ to revive Blyth’s genus *Batasio* and to describe this fish as *Batasio batasio* (Hamilton).

Having cleared the systematic position of *Batasio* Blyth from a study of the fresh material of *B. batasio* (Ham.) obtained from its type-locality, we may now consider which other species can be assigned to this genus. We have indicated above (*vide supra*, p. 13) that Hamilton’s *Pimelodus tengana*,⁶ as surmised by Blyth already (*vide supra*, p. 28), belongs to this genus. In a recent collection made by one of us (S. L. H.) from the Terai and Duars there are several specimens which are referable to this species, though the colouration, which is variable, differs from that described by Hamilton. He observed that :—

“.....The body is diaphanous, with a silver coloured membrane investing the viscera and spine, and with a gloss of gold on the sides. On the back are many black dots, which are collected into a spot above each pectoral fin, and also on the crown of the head. The fins of the back and tail also are dotted, so that the edge of the last is black, and several spots are formed on the first.”

¹ Day, F., *Fish. India*, p. 492 (1877).

² Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, pp. 211-217, 230-235 (1890).

³ Hora, S. L., *Rec. Ind. Mus.* XXII, p. 179 (1921).

⁴ Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1a, 1b (1913).

⁵ Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, pp. 97, 98, text-fig. 98, 1937 (1938).

⁶ Hamilton, F., *Fish. Ganges*, p. 176, pl. xxxix, fig. 58 (Edinburgh, 1822).

Hamilton found this species in the Brahmaputra river at Goalpara. In the adult specimens from the Terai and Duars the colouration is more or less similar to that described by Hamilton but in the younger specimens the body is marked with a few oblique bands and spots, and the distal half of the anterior rays of the dorsal fin is black. On the whole the colour seems to vary considerably with age (*vide infra*, p. 38).

In describing *Batasio affinis*, Blyth¹ remarked :—

“Exceedingly like *B. Buchanani*, as described by Buchanan Hamilton and as figured in one of his unpublished coloured drawings; whereas his published figure (F. G. pl. xxiii, f. 60) refers to his *Pimelodus carcio*, which is a true *Bagrus* with moderately long maxillary cirri :—but having 12 instead of 16 anal rays, no distinct longitudinal black stripe on each side of the body, but a tendency to show three or four black broad cross-bands, more or less distinct, besides a round black spot near the gill-covers, as in the other. The first dark band proceeds obliquely downwards from the fore-part of the first dorsal, to some distance below the lateral line; and posterior to this first band are obscure traces of three or four others, the last at base of tail. On the membrane of the dorsal fin is a large blackish spot, consisting of minute dark specks.”

The type of Blyth's species is preserved in the collection of the Indian Museum, and though its colouration has faded there can be no doubt of its identity with the specimen of Hamilton's *Pimelodus tengana* from the Tista River System.

In his 'Supplement' to the 'Fishes of India' (1888, p. 805), Day described *Leiocassis fluviatilis*, a species of freshwater fish found by Day in Col. Tickell's "volume of beautiful coloured drawings of Burmese Fishes with their descriptions", of which Col. Tickell is stated to have "obtained four examples, the largest 3½ inches long from the Anin, a steam rising near Weywoon, Wagroo in the Tenasserim Provinces". The identity of this species is still in doubt, but recently Hora and Gupta examined six specimens from the Chenderoh Lake, Perak, in the collection of the Raffles Museum, Singapore, which they referred to this species. The most characteristic feature of *L. fluviatilis* is its colouration, which, according to Day (*loc. cit.*), is as follows :—

“Yellowish horny with darker shades of olive brown on the snout and along the back, also some cloudy markings. A large black blotch on the lateral-line above the anal fin, another between the pectoral and first dorsal. Tip of dorsal and ends of both caudal lobes black.”

In the examples from Perak the black blotch on the lateral line above the anal fin is very conspicuously marked, while the anterior blotch represents the area against which the air-bladder comes directly in contact with the skin. Another conspicuous feature of these examples is an oblique horseshoe-shaped band lying in front of the first dorsal fin and descending on the sides to below the lateral line. Sometimes this band breaks up into a dorsal blotch and two oblique bars on the sides. There is a submarginal band on the dorsal fin and the tips of the caudal fins are somewhat dusky but not black.

Day observed that with the exception of the maxillary pair of barbels no others were detected. We find that there are two pairs of mandibular barbels, the outer being more or less equal to the diameter of the eye while the inner are very rudimentary. The nasal barbels extend

¹ Blyth, E., *Journ. As. Soc. Bengal* XXIX, p. 149 (1860).

to the front border of the eye or slightly beyond it. The maxillary barbels, as noted by Day, extend as far as the posterior border of the orbit.

A comparison of the Perak examples with those of *Pimelodus tengana* from the Eastern Himalayas and of *Batasio affinis* from Tenasserim leaves little doubt of their identity. We are, therefore, led to conclude that Day's *Leiocassis fluviatilis* is a synonym of *Batasio tengana* (Ham.).

Vinciguerra's¹ *Macrones dayi* is stated to be closely allied to *Leiocassis fluviatilis* Day and *Batasio affinis* Blyth, only differing in proportions and colouration. From a study of a large number of specimens we have found that such differences have no specific value and we are of opinion, therefore, that *M. dayi* is also a synonym of *Batasio tengana* (Ham.). Chaudhuri's² *M. marianiensis*, described from the Brahmaputra River System, Assam, and later recorded from the streams at the base of the Eastern Himalayas, is also a synonym of *B. tengana*. The species described and figured by Shaw and Shebbeare³ as *Leiocassis rama* is also referable to *B. tengana*. Regarding this species Shaw and Shebbeare noted :—

“ In general appearance resembles those species of *Mystus* which have a shoulder-blotch and longitudinal bands but has much shorter barbels. It therefore somewhat resembles *Batasio batasio* from which it is distinguished by having a shorter adipose fin and a longer anal.”

Recently we obtained a number of specimens from Travancore in which the body is of deep gray colour and is devoid of any transverse oblique bands or spots. These specimens are of a somewhat larger size and on morphological characters represent a new species of *Batasio*. In the present-day discontinuous distribution of this genus we have another record of the common origin of the fauna of the Malay Peninsula and that of Peninsular India.

Besides *Batasio batasio* (Ham.) and *B. tengana* (Ham.), there are two other species of Hamilton's *Pimelodus* which have been assigned by Blyth to *Batasio*, viz., *P. chandramara* and *P. rama*. Hamilton⁴ recognised the great similarity between these species and separated them on the following characters :—

P. chandramara.

P. rama.

- | | |
|---|---|
| 1. Two barbels. | 1. Six barbels. |
| 2. Diaphanous with clusters of black dots ; golden stripe along lateral line. | 2. Diaphanous, yellowish without dots. Black spot on nape, divided into four lobes. |
| 3. A. 17. | 3. A. 15. |

As pointed out by Blyth, Hamilton's original figure of *P. chandramara*⁵ shows six distinct barbels. The other two points of difference are not of specific value as the colour may vary according to habitats

¹ Vinciguerra, D., *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230 (1890).

² Chaudhuri, B. L., *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1a, 1b (1913).

³ Shaw, G. E. and Shebbeare, E. O., *Journ. Roy. As. Soc. Bengal, Science* III, p. 90 text-fig. 88, pl. 3, fig. 4, 1937 (1938).

⁴ Hamilton, F., *Fish. Ganges*, pp. 162, 176 (Edinburgh, 1822).

⁵ Vide Hora, S. L., *Mem. Ind. Mus.* IX, pl. xxi, fig. 6 (1929).

and the difference in the number of anal rays may be due to individual variation. Both the species were described from Northern Bengal.¹

Hamilton's descriptions of both the species are brief and inadequate for their specific determination, and, as pointed out by Blyth (*loc. cit.*), there are discrepancies between his descriptions and figures. For instance, Hamilton stated in his description that *P. chandramara* possesses only "two tendrils", whereas in his unpublished figure 6 barbels are distinctly shown. The consideration of the number of barbels alone seems to have led Swainson² and Cuvier & Valenciennes³ to refer *P. chandramara* to the genera *Silonia* and *Silundia* respectively. It may be stated without any fear of contradiction that Hamilton's species does not belong to either of these genera. Blyth placed it in the genus *Batasio* but without examining any specimen of the species; his conclusion seems to have been based on a study of the unpublished drawing of the species. In the two species of *Batasio* referred to above, there is a distinct nasal barbel, which is neither described nor shown in the figure of *Pimelodus chandramara*. Günther⁴ referred *P. rama* very doubtfully to the genus *Rita*, but considering the large size of its eyes, general facies and habitat, it is difficult to place it among *Rita*. Day⁵ examined a specimen from Assam, which undoubtedly belongs to this species and regarded it as *Leiocassis*.⁶ On a careful analysis of Day's description it is found that the species shows affinities with both *Batasio* and *Leiocassis*. For instance, the subcutaneous nature of the eyes is a character of *Leiocassis*, but their relatively large size is a character of *Batasio*. The absence of the nasal barbels, however, precludes it from either of the genera. We have examined Day's specimen from Assam, which is in a poor state of preservation, and have found open pores along the lower jaw and edges of the gill-covers which are characteristic of *Batasio*. In view of what is stated above, and in the absence of good and reliable material it is perhaps desirable to keep *Pimelodus rama* in a separate genus for which Bleeker has already proposed the name *Rama*.

In 1931, H. M. Smith⁷ described from Siam a strikingly marked little catfish and referred it to the genus *Mystus*. The colouration and general build of this species, *M. havmolleri*, are very similar to

¹ Day (*Fish. India*, p. 452, 1877) notes that "In Ham. Buch. MSS. *P. chandramara* is said to be found in the Rangpur district in the Mahánandá and also in the Dinajpur district. In Purniah he records it as termed Thūnka-pátasī of the Kusī and Khāmaññ at Bholáhát. In the 'Fishes of the Ganges', he remarks that *P. rama* is from the Brahmaputra. The fish I have here described from the same locality, appears to be a link between the two forms, as the Assam one is said to have on nape a large black spot divided into four lobes, and which is not present in my specimens, which it is said to differ from *P. chandramara*, chiefly in the latter being deficient in this mark. I have referred my specimen to *P. rama* as it came from Assam.

² Swainson, W., *Nat. Hist. Classification Fish. Amph. Rept.* II, p. 305 (1839).

³ Cuvier, G. and Valenciennes, A., *Hist. Nat. Poiss.* XV, p. 49 (1840).

⁴ Günther, A., *Cat. Fish. Brit. Mus.* V, p. 92 (1864).

⁵ Day, F., *Fish. India*, p. 451 (London, 1877).

⁶ Regan [*Ann. Mag. Nat. Hist.* (8) II, p. 547, 1913] observed that "*Pimelodus rama* Ham. Buch., from Bengal and Assam, is placed by Day in *Leiocassis* (*Fish. India*, p. 451 pl. cxv, fig. 2); it seems improbable that this little fish really belongs to the genus; but if it does, the large eye and minute mandibulatory barbels distinguish it from all the other species".

⁷ Smith, H. M., *Proc. U. S. Nat. Mus.* LXXIX, Art. 7, p. 24, fig. 24 (1931).

Batasio tengana, though in the size of its eyes, barbels and adipose dorsal it is somewhat different. It is stated to be provided with "a transverse row of 4 large pores behind lower lip; entire snout thickly beset with minute pores" A more detailed description of the species is necessary to determine its precise specific limits but there can hardly be any doubt of its position in the genus *Batasio*. In fact, its resemblance to *B. tengana* is so close that, in the present state of our knowledge we consider that the differences between the two are not of specific value.

From the above it will be clear that in the present state of our knowledge only three Indian species can definitely be assigned to the genus *Batasio*. These can be distinguished by the following key:—

Key to the Indian species of Batasio Blyth.

- A. Base of adipose dorsal considerably longer than that of anal.
 - I. Body marked with longitudinal bands; a conspicuous dark spot above pectoral. [Median groove on head continued on occipital process for some distance; occipital process extending over basal bone of dorsal and meeting first dorsal spine; no pores on dorsal surface of head.] .. *B. batasio.*
 - II. Body without longitudinal bands or spots. [Median groove on head extending to base of occipital process; occipital process separated from basal bone of dorsal fin by a considerable distance; pores on dorsal surface of head present] .. *B. travancoria.*
- B. Base of adipose dorsal shorter or equal to base of anal. [Median groove on head extending to end of occipital process and in its posterior portion containing basal bone of dorsal fin; no pores on dorsal surface of head; body marked with oblique vertical bands or spots.] .. *B. tengana.*

***Batasio batasio* (Hamilton).**

Plate II, figs. 4-6.

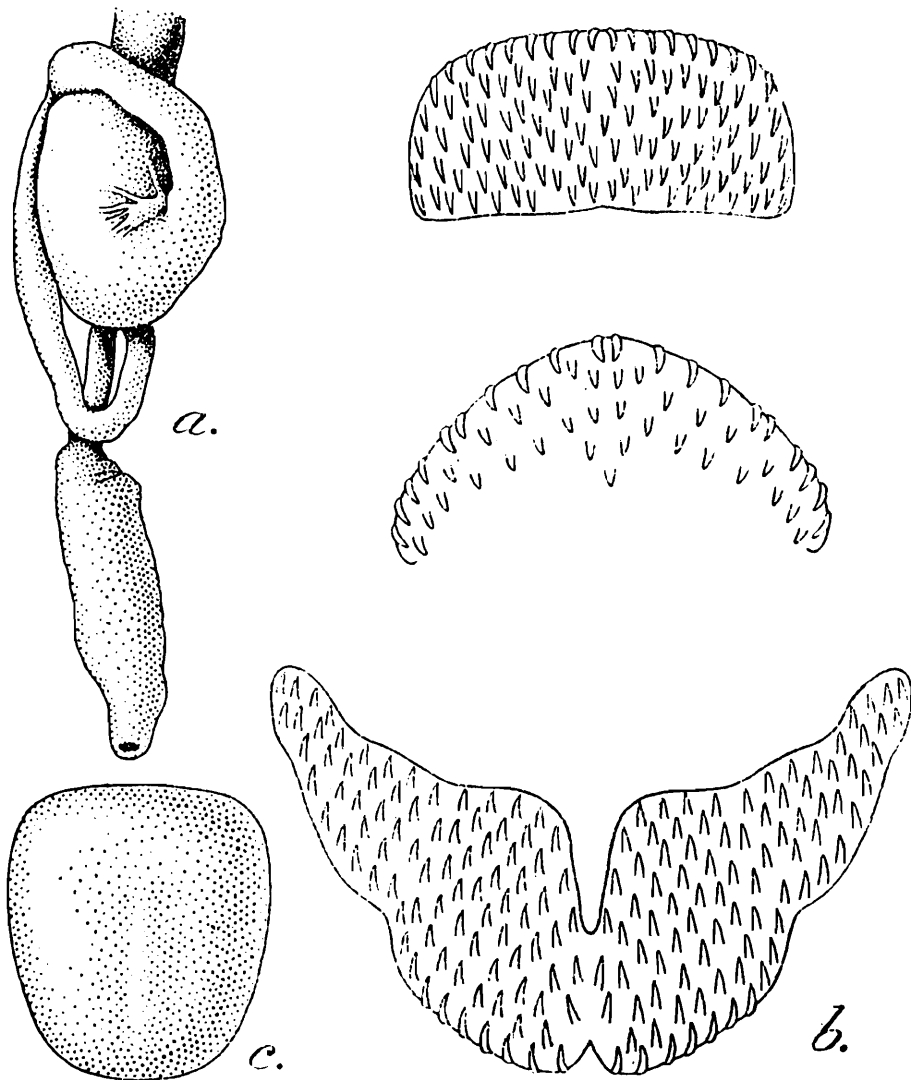
- 1822. *Pimelodus batasio*, Hamilton, *Fish. Ganges*, pp. 179, 377. (The drawing on pl. xxiii, fig. 60 does not refer to this species, but to *P. carcio* described on p. 181).
- 1839. *Bagrus batasio*, Cuvier and Valenciennes, *Hist. Nat. Poiss.* XIV, p. 425.
- 1860. *Batasio Buchanani*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
- 1862. ? *Batasio Buchanani*, Bleeker, *Atl. Ichthyol.* II, p. 8.
- 1863. ? *Batasio Buchanani*, Bleeker, *Ned. Tijdschr. Dierkund.* I, p. 94.
- 1864. *Macrones batasio*, Günther, *Cat. Fish. Brit. Mus.* V, p. 83.
- 1877. *Gagata batasio*, Day, *Fish. India*, p. 493, pl. xcix, fig. 5 (Hamilton's MS. drawing reproduced).
- 1889. *Gagata batasio*, Day, *Faun. Brit. Ind. Fish.* I, p. 209.
- 1929. *Pimelodus batasio*, Hora, *Mem. Ind. Mus.* IX, pl. xxii, fig. 3.
- 1938. *Batasio batasio*, Shaw and Shebbeare, *Journ. Roy. As. Soc. Bengal, Science* III, p. 97, fig. 98.

D. 2/7; A. 3-4/9-10; P. 1/5-8; V 1/5; C. 17.

Batasio batasio is a medium-sized species in which the dorsal and the ventral profiles are moderately arched. The dorsal profile rises gradually from the tip of the snout to the origin of the dorsal fin whence it slopes down gradually to caudal peduncle where it is horizontal. The ventral profile is horizontal and flattish just for a short distance between the head and pelvic fins, thence it rises gradually towards

both ends. The body is compressed from side to side, more so in the tail region.

The head is sharp, bluntly pointed and conical; its length is contained from 3.61 to 3.90 times in the standard length. The height of the head is contained from 1.34 to 1.71 times and its width from 1.43 to 2.38 times in its length. The snout is fairly long and pointed; it projects in front of the mouth for a short distance. The eyes are of a moderate size and dorso-lateral in position; they are not visible from the ventral surface. The orbital margins are free. The diameter of the eye is contained from 2.63 to 3.30 times in the length of the head, from 1.14 to 1.53 times in the length of the snout and from 0.71 to 1.20



Text-fig. 2.—Alimentary canal, dentition and air-bladder of *Batasio batasio* (Hamilton).

a. Alimentary canal: $\times 2\frac{1}{2}$. b. Dentition: $\times 12$. c. Air-bladder: $\times 2\frac{1}{2}$.

times in the interorbital width. The two nostrils of each side are wide apart and are not so conspicuous as in the species of *Gagata*. The anterior nostril is placed above the base of the maxillary barbel and much nearer the tip of the snout than the eye; while the second pair is closer to the eye than to the anterior nostril. The median groove on the head is long and narrow; it extends from between the posterior nostrils to one-third of the occipital process; the lateral edges of the groove are slightly raised into longitudinal ridges. In the groove,

there are two fontanels which are separated by a broad bony ridge ; the anterior fontanel extends over the anterior two-thirds of the eye, while the posterior fontanel commences from behind the eye and extends for a short distance over the occipital process. The occipital process is long and broad ; its length is almost $3\frac{1}{2}$ times its width at the base ; it extends over the basal bone of the dorsal fin. The mouth is inferior, crescentic and horizontal ; it is bordered by fleshy lips which are continuous at the angles of the mouth. The labial groove is broadly interrupted in the middle ; both the lips are distinctly fimbriated. Behind the lower lip there are four slit-like openings and four pairs of pores on the ventral surface of head running obliquely from the mandibular barbels to the gill-openings. The teeth are small and villiform ; they are arranged in broad continuous bands in the jaws and in a similar band on the palate. There are four pairs of barbels ; the nasal barbels, which are placed at the anterior end of the posterior nostrils, are small and considerably shorter than the diameter of the eye ; the maxillary barbels do not extend beyond the posterior margin of the orbit and the mandibular barbels are still shorter ; the bases of the latter are not situated exactly in a transverse line behind the lower lip, but those of the inner pair are slightly in advance of those of the outer. The gill-membranes are notched anteriorly and the gill-openings are very extensive.

The depth of the body is contained from 3.72 to 4.40 times in the standard length. The least height of the caudal peduncle is contained from 1.33 to 1.57 in its length. The portion of the body where the air-bladder comes in contact with the skin is well marked externally. The cubito-humeral processes are also well developed. The external features of the urino-genital organs are similar to those as described above in the species of *Gagata* (*vide supra*, p. 16). In ripe males the urinogenital papilla is well marked.

The rayed dorsal fin is situated well in advance of that of the pelvics, but its base extends almost over the pelvic fins ; its longest ray is shorter than the length of the head and the spine is much shorter. The dorsal spine is a strong prickle which is smooth along both the borders. The adipose dorsal is considerably long and well marked ; the length of its base is equal to or greater than the length of its head. The pectoral fins are horizontally placed and are shorter than the head ; they are separated from the pelvic fins by a considerable distance. The pectoral spine is strong and broad ; it is smooth along the outer border but is strongly denticulated internally. The pelvic fins extend beyond the anal opening but do not reach the base of the anal fin. The caudal fin is deeply forked with both the lobes sharply pointed.

Hamilton noted that the fish is provided "with a diaphanous body, having on each side two stripes dotted with black. The cavity containing the viscera is lined with a silver coloured membrane ; and, besides the two stripes, the fish has on each shoulder a spot composed of black dots. The first dorsal fin is spotted, the second is dotted." Shaw and Shebbeare described the colouration as follows :—

"Leadens above, yellow beneath. A dark longitudinal band along the lateral line expanding into a shoulder-blotch immediately below the dorsal fin. A second fainter and somewhat curved dark band midway between the lateral line and the

dorsal ridge, commencing at the top of the opercle and ending about the middle of the adipose fin. It is connected with the dark colour of the dorsal ridge at the front part of the rayed dorsal."

Distribution.—*Batasio batasio* is known so far from the Tista River System. We have examined several specimens from the streams of Terai and Duars.

Measurements in millimetres.

Standard length ..	55.0	65.0	69.0	75.0	84.0	89.5
Length of head ..	14.5	18.0	19.0	20.5	21.5	23.0
Height of head at occiput	9.5	10.5	13.0	14.0	16.0	15.0
Width of head	9.0	10.0	12.5	13.8	9.0	16.0
Length of snout	6.5	7.5	8.0	8.0	10.0	10.0
Diameter of eye ..	5.5	6.0	7.0	7.0	6.5	7.0
Interorbital width ..	4.5	5.0	5.0	5.0	6.0	6.5
Depth of body	12.5	15.0	18.5	17.5	23.5	23.0
Length of caudal peduncle	8.0	9.0	11.0	11.0	12.5	12.0
Least height of caudal peduncle..	5.5	6.5	7.0	8.0	8.5	9.0
Longest ray of dorsal	10.0	11.5	13.0	14.0	D.	14.5
Length of dorsal spine	9.0	12.0	9.5	12.0	D.	D.
Length of pectoral ..	11.0	12.0	14.0	13.0	14.5	14.0
Length of pectoral spine ..	10.0	11.0	12.0	D.	13.0	13.0
Length of ventral ..	8.5	12.0	10.0	11.0	10.5	13.0
Longest ray of anal ..	11.0	9.5	9.5	11.5	15.5	D.
Length of base of anal	10.5	10.0	12.0	11.5	14.5	11.0
Length of base of adipose dorsal	19.0	16.5	19.0	22.0	21.5	23.0

Batasio tengana (Hamilton).

Plate II, figs. 1-3.

1822. *Pimelodus tengana*, Hamilton, *Fish. Ganges*, pp. 176, 377, pl. xxxix, fig. 58.
1839. *Bagrus tengana*, Cuvier & Valenciennes, *Hist. Nat. Poiss.* XIV, p. 433.
1854. *Bagrus tengana*, Bleeker, *Verh. Bat. Gen.* XXV, p. 56.
1860. *Batasio affinis*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1860. *Batasio tengana*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150.
1864. *Macrones affinis*, Günther, *Cat. Fish. Brit. Mus.* V, p. 83.
1864. *Macrones tengana*, Günther, *Cat. Fish. Brit. Mus.* V, p. 84.
1873. *Macrones affinis*, Day, *Proc. Zool. Soc. London*, p. 111.
1877. *Macrones Blythii*, Day, *Fish. India*, p. 445.
1877. *Gagata tengana*, Day, *Fish. India*, p. 493.
1888. *Leiocassis fluviatilis*, Day, *Fish. India Suppl.*, p. 805.
1889. *Leiocassis fluviatilis*, Day, *Faun. Brit. Ind. Fish.* I, p. 164.
1889. *Macrones blythii*, Day, *Faun. Brit. Ind. Fish.* I, p. 151.
1889. *Gagata tengana*, Day, *Faun. Brit. Ind. Fish.* I, p. 210.
1890. *Macrones Dayi*, Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova* (2) IX, p. 230, pl. vii, fig. 3.
1913. *Macrones marianiensis*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 253, pl. xi, figs. 1, 1a, 1b.
1921. *Macrones (Macronoides) affinis*, Hora, *Rec. Ind. Mus.* XXII, p. 180.
1921. *Macrones (Macronoides) merianiensis*, Hora, *Rec. Ind. Mus.* XXII, p. 736.
1931. *Mystus havmolleri*, H. M. Smith, *Proc. U. S. Nat. Mus.* LXXIX, art. 7, p. 24, fig. 12.
1937. *Leiocassis rama*, Shaw & Shebbeare (*nec* Hamilton), *Journ. Roy. Asiat. Soc. Bengal, Science* III, p. 90, text-fig. 88, pl. iii, fig. 4.

D. 2/7-8 ; A. 3-4/8-11 ; P. 1/7-9 ; V 1/5 ; C. 16-18.

Batasio tengana is a small, well-built species in which both the dorsal and the ventral profiles are somewhat arched; the body is deepest about the commencement of the dorsal fin and from that point it tapers both anteriorly and posteriorly. The ventral surface between the pectorals is only slightly flattened, but that of the head is flattish. The fish is compressed from side to side; this is more marked in the tail region.

The head is broadly pointed anteriorly and the snout is produced beyond the mouth for a short distance. The length of the head is contained from 3.58 to 4.17 times in the standard length; the height of the head is contained from 1.35 to 1.78 times and its breadth from 1.36 to 1.70 times in its length. The eyes are of a moderate size and are dorso-lateral in position; they are not visible from the ventral surface, and are situated almost in the middle of the length of the head. The diameter of the eye is contained from 2.50 to 3.40 times in the length of the head and from 0.87 to 1.4 times in the length of the snout. The interorbital distance is considerably less than the diameter of the eye. The nostrils are situated wide apart; the anterior nostril is tubular and directed forwards; the posterior nostril is situated almost midway between the eye and the tip of the snout and is provided with a nasal barbel at its anterior end. The median groove on the head is long and narrow; it extends from behind the posterior nostrils to the end of the occipital process; its margins form slightly elevated ridges. In the groove, there are two median fontanels which extend to the base of the occipital process and are separated from each other by a narrow ridge situated behind the eyes. The anterior part of the basal bone of the dorsal fin is lodged in the median groove of the occipital process, which is long and narrow. The mouth is small, inferior, horizontal and crescentic; it is bordered by fleshy lips which are continuous and pendulous at the corners of the mouth. The labial groove is broadly interrupted in the middle; both the lips are distinctly fimbriated. Behind the lower lip there are five slit-like oval openings and four pairs of small round holes situated obliquely between the bases of the mandibular barbels and the gill-openings. The teeth are small and villiform; those in the jaws form oval patches while those on the palate form a lunate band. There are four pairs of barbels; the nasal barbels extend to the anterior border of the orbit or a little farther; the maxillary barbels are the longest but are just about half the length of the head and the mandibular barbels are considerably shorter. The bases of the mandibular barbels are situated at a considerable distance behind the mouth and are not in a straight line, those of the inner pair being somewhat in advance of those of the outer. The gill-openings are very extensive and the gill-membranes are deeply notched anteriorly.

The depth of the body is contained from 3.69 to 4.65 times in the standard length. The least height of the caudal peduncle is contained from 0.84 to 1.60 times in its length. The portion of the body where the air-bladder comes in contact with the skin is well-marked. The cubito-humeral processes are narrow and can be readily felt through

the skin. The external features of the urinogenital organs are similar to those of *Batasio batasio*.

The rayed dorsal fin is situated considerably in advance of the pelvic fins, but its base extends almost over their commencement. The longest ray of the dorsal fin is considerably shorter than the head and the spine is still shorter. The dorsal spine is a smooth, moderately strong prickle. The adipose dorsal, though well marked, is not so extensive as that of *B. batasio*; it commences considerably behind the rayed dorsal and its base is somewhat shorter than the head. The pectoral fins are situated slightly above the ventral surface of the body; they are much shorter than the head and are separated from the pelvic fins by a considerable distance. The pectoral spine is flattened and strong; it is smooth externally but strongly denticulated internally. The pelvic fins are shorter than the pectorals and extend beyond the anal opening but not as far as the urinogenital openings. The anal fin is situated below the adipose dorsal and its base is slightly longer than that of the rayed dorsal. The caudal fin is deeply forked, with the lower lobe somewhat better developed; both the lobes are bluntly pointed.

As indicated above (*vide supra*, p. 30), the colour varies considerably with the size of the specimens and locality. In fresh specimens collected from the streams of Terai and Duars, Tista River System, the general surface is gray-olivaceous which is deeper above and lighter below. The dorsal surface of the head is dark with an indication of a band in the region of the eyes; this band passes on the sides below the eyes but does not extend to the ventral surface. There is a broad black spot on the nape. Behind the head there is an oblique darkish band dorsally which extends to the sides and joins the black blotches in the region above the pectorals where the air-bladder comes in contact with the skin. The rest of the body is marked with five oblique, saddle-shaped bands of varying depth of colour which do not extend to the ventral surface, the first is at the commencement of the rayed dorsal fin, the second at its termination, the third below the anterior part of the adipose dorsal, the fourth below the posterior part of the adipose dorsal and the last in front of the base of the caudal fin. The distal portions of the anterior rays of the dorsal fin are dark and form a broad patch. The other fins are somewhat dusky. The colour variations consist in the suppression or intensification of some of these markings, but the general colour plan remains more or less similar. For this reason we have attached no significance to colour variations in recognising species established on this character alone.

Distribution.—*Batasio tengana* was originally described from the Brahmaputra river. We have examined several specimens from below the Darjeeling Himalayas, Assam, Tenasserim, Mergui and Perak. It is also found in Siam (Klong Thalerng, near Ronpibun, Peninsular Siam), from where it was described as *Mystus havmolleri* by H. M. Smith. In the Siamese examples the eyes are considerably smaller and the adipose dorsal relatively longer. As judged from the figure the barbels, especially the maxillary pair, appear to be somewhat longer. In view of these differences it may perhaps be desirable to regard *M. havmolleri* as a variety of *B. tengana*.

Measurements in millimetres.

	Bengal.										Assam.				Tenasserim.	Tasing, Mergui Expedition.	Chenderoh Lake, Perak.	
Standard length	38.5	40.0	43.5	46.0	48.0	49.0	54.5	54.5	56.0	60.0	41.5	57.5	64.5	68.5	63.0	74.0	53.5	61.0
Length of head	10.5	11.0	11.0	12.5	11.5	13.0	15.0	14.5	13.5	15.0	10.0	15.5	16.5	17.5	16.5	20.5	14.0	17.0
Height of head at occiput ..	6.5	6.5	7.0	9.0	7.0	9.0	8.5	9.0	10.0	9.5	6.5	9.5	11.0	11.0	11.0	15.0	10.0	9.5
Width of head	7.0	7.0	7.0	8.0	7.0	9.5	9.5	9.5	9.5	10.0	6.5	9.8	12.0	11.5	11.5	14.5	10.0	10.0
Length of snout	3.5	4.0	4.0	4.5	4.0	5.0	5.5	5.5	5.0	6.0	4.0	5.5	6.0	6.0	5.5	8.5	6.0	7.0
Diameter of eye	4.0	3.5	3.5	4.0	3.5	4.5	4.5	4.5	4.5	4.5	4.0	5.0	5.0	5.5	6.0	7.0	5.0	5.0
Interorbital width	3.0	3.0	3.0	3.0	3.0	3.5	4.0	3.5	4.0	4.0	2.5	3.5	4.0	4.5	5.0	5.0	4.0	4.0
Depth of body .	9.0	9.0	10.5	11.5	10.5	11.5	12.0	13.0	14.5	15.0	9.5	14.5	14.5	18.5	16.0	19.5	12.5	16.5
Length of caudal peduncle	5.0	6.5	8.0	8.0	8.0	6.5	8.0	7.0	11.0	10.5	6.0	9.0	10.0	10.0	7.0	9.0	5.5	7.5
Least height of caudal peduncle	4.5	5.0	5.0	5.7	5.5	5.5	6.5	6.0	7.0	7.0	4.0	6.0	7.5	8.5	7.8	8.0	6.5	6.5
Longest ray of dorsal	8.0	9.0	9.5	10.0	10.0	11.0	12.0	11.5	10.5	13.0	9.0	11.0	13.0	12.0	D.	16.0	10.0	11.5
Length of dorsal spine	6.5	7.0	7.0	8.5	7.5	8.0	9.0	9.0	9.0	10.0	5.5	8.0	10.0	9.5	9.5	9.5	7.0	7.0
Length of pectoral	8.5	9.0	10.5	8.5	10.5	9.0	11.5	11.0	12.0	10.0	9.0	10.5	14.5	14.0	11.0	17.0	12.0	11.5
Length of pectoral spine	7.5	9.5	8.0	8.0	8.5	8.0	9.0	8.5	9.5	D.	6.5	8.0	10.5	10.5	10.0	13.0	9.5	8.0
Length of ventral	6.5	6.5	8.0	7.5	7.0	6.5	8.0	10.0	9.0	9.5	6.0	9.0	10.5	9.5	9.5	12.0	9.0	9.5
Longest ray of anal	8.0	6.0	9.0	8.0	10.0	9.5	8.5	11.0	9.5	12.5	8.5	9.5	13.5	13.5	11.0	D.	10.0	10.5
Length of base of anal	6.0	6.5	6.0	7.0	6.5	8.0	7.0	8.5	7.0	10.5	5.5	8.5	10.0	10.0	9.0	12.0	8.0	6.0
Length of base of adipose dorsal.	8.5	10.0	7.5	10.5	12.5	9.5	13.0	12.0	11.5	14.0	7.0	10.5	14.0	17.5	13.5	22.5	13.5	16.0

Batasio travancoria, sp. nov.

Plate II, figs. 7-9.

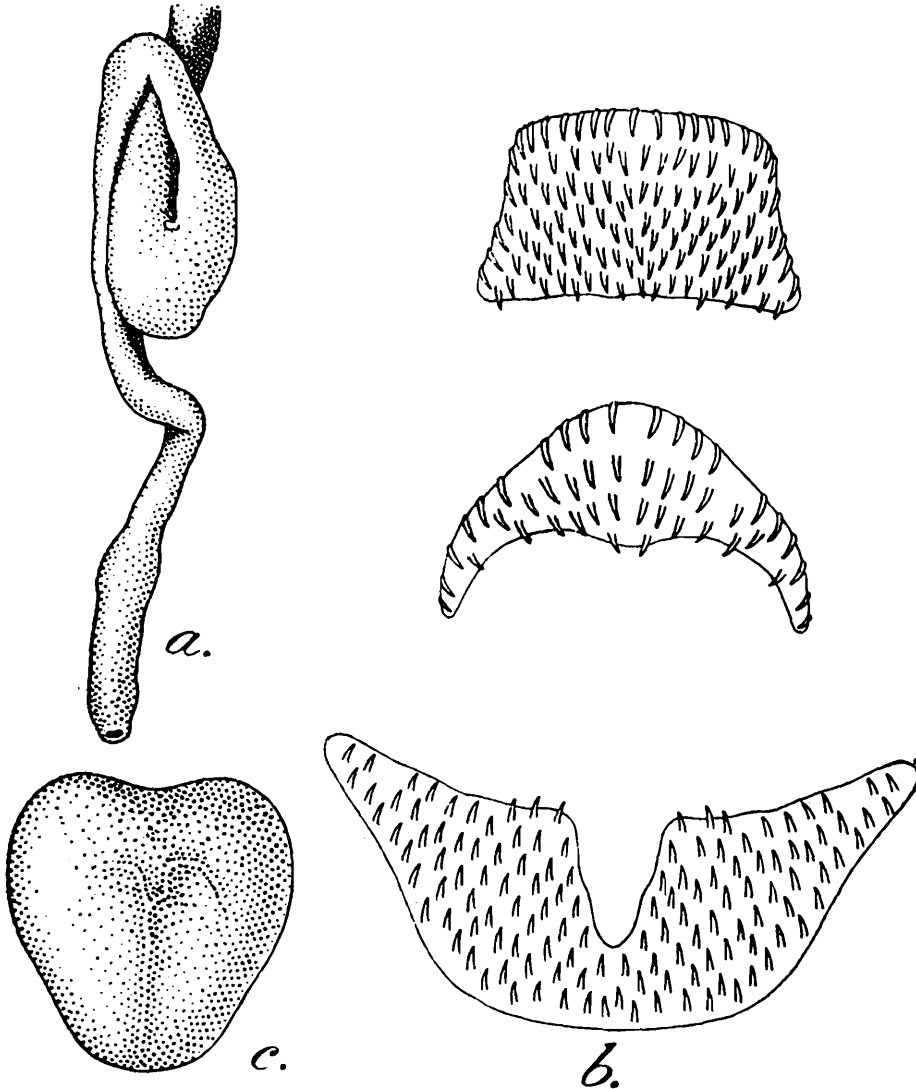
D. 2/7 ; A. 3-4/9-11 ; P. 1/7-9 ; V 1/5 ; C. 16-19.

Batasio travancoria is an elongated, medium-sized fish, in which the dorsal profile is slightly arched while the ventral profile is more or less horizontal in front of the pelvic fins, after which it is slightly arched. The ventral surface of the head and the anterior part of the body are somewhat flattened. The fish is subcylindrical anteriorly and compressed posteriorly.

The head is globular, conical and rounded anteriorly ; its length is contained from 3.87 to 4.35 times in the standard length. The height of the head is contained from 1.44 to 1.81 times and its width from 1.32 to 1.53 times in its length. The snout is rounded and projects beyond the mouth for a short distance ; it is longer than the postorbital part of the head. The eyes are of a moderate size and are dorso-lateral in position ; they are not visible from the ventral surface. The diameter of the eye is contained from 2.72 to 3.10 times in the length of the head, from 0.93 to 1.28 times in the length of the snout and from 0.50 to 0.81 times in the interorbital width. The nostrils are situated wide apart ; the anterior nostrils are tubular and are directed forwards while the posterior nostrils are situated much nearer the eye than the anterior nostrils and are provided with nasal barbels. The median groove on the head is long and narrow ; it extends from slightly in front of the posterior nostrils to the base of the occipital process or slightly farther and in it are lodged two fontanels separated by a narrow ridge. At the sides of the median groove there is a series of 3 small fontanels on either side. The occipital process is long and sharply pointed posteriorly ; it is separated from the basal bone of the dorsal fin by a considerable distance. The mouth is small, inferior, lunate and horizontal ; it is bordered by fleshy lips which are pendulous and continuous at the angles of the mouth ; the labial groove is widely interrupted. The lips are slightly crenulate but not fimbriate as in the other two species. There are five large oval pores behind the lower lip and two series of six pores each situated obliquely between the angle of the mouth and the gill-cover. There are pores between the nostrils, below the eyes and along the free borders of the gill-covers. The teeth are small and villiform ; they are arranged in bands in the jaws and on the palate. There are eight barbels ; the nasal barbels are situated at the anterior border of the posterior nostrils and extend to about the middle of the eye ; the maxillary barbels are short and do not extend beyond the eyes ; the outer mandibular barbels are as long as the nasal barbels while those of the inner pair are much shorter. The bases of the mandibular barbels are not situated in a straight line ; those of the inner pair are in advance of those of the outer. The gill-openings are extensive and the gill-membranes are notched anteriorly.

The depth of the body is contained from 4.86 to 5.48 times in the standard length. The least height of the caudal peduncle is contained from 1.01 to 1.29 times in its length. The portion of the body where

the air-bladder comes in contact with the skin is fairly well marked externally, and the cubito-humeral processes can be readily felt through the skin. The external features of the urinogenital organs are similar to those described for the other species. The urinogenital papilla is well marked, especially in the males.



Text-fig. 3.—Alimentary canal, dentition and air-bladder of *Batasio travancoria*, sp. nov.
 a. Alimentary canal. $\times ca 2\frac{1}{2}$. b. Dentition : $\times 15$. c. Air-bladder. $\times 2\frac{1}{2}$.

The rayed dorsal fin is situated almost entirely in advance of the pelvics ; its longest ray is considerably shorter than the head. The dorsal spine is comparatively weak and is slightly crenulated along both the borders ; it is slightly longer than half the length of the head. The adipose dorsal commences as a slightly raised ridge behind the base of the rayed dorsal, but after the termination of the dorsal when laid flat it becomes a long, prominent ridge ; the length of its base is considerably greater than the length of the head. The pectoral fin is considerably shorter than the head and is separated from the pelvics by about half of its length. The pectoral spine is moderately developed ; it is smooth externally but denticulated internally. The pelvic fins are horizontal and extend considerably beyond the anal opening to the urinogenital papilla. The anal fin is low and the length of its base is almost equal to the base of the rayed dorsal fin. The caudal fin is

deeply forked with the lobes rounded ; the lower lobe is better developed than the upper.

The colouration in spirit is uniformly gray with the exception of a narrow dark streak along the lateral line. The gray colour is somewhat deeper on the head and the dorsal surface and lighter on the side. The ventral surface is much lighter. All the fins are more or less dusky.

Distribution.—*Batasio travancoria* is represented in the collection of the Zoological Survey of India by five specimens, which were collected by Dr. C. C. John from the following localities in Travancore :

Locality.	No. of specimens.
Peruntenaruvi, a tributary of the Pamba R., at Edakadathy ..	1
Kolathupuzha, a tributary of the Kallada R.	2
Chittar R., Palode	1
Kallada R., 4 miles east of Thenmalai.. ..	1

Type-specimen.—F. 13449/1, Zoological Survey of India (*Indian Museum*), Calcutta.

Measurements in millimetres.

Standard length	56.5	59.0	65.0	74.0	79.0
Length of head	14.5	15.0	15.5	17.0	20.5
Height of head at occiput	8.0	10.0	10.0	11.8	14.0
Width of head	10.0	9.8	11.2	12.8	14.5
Length of snout	5.0	5.7	6.4	6.5	7.0
Diameter of eye	5.2	5.5	5.0	5.5	7.5
Interorbital width.. ..	3.8	3.0	4.0	4.5	3.7
Depth of body	11.5	11.5	12.0	15.2	14.5
Length of caudal peduncle	7.5	6.6	8.0	10.0	9.5
Least height of caudal peduncle	5.8	6.5	6.5	8.0	8.5
Longest ray of dorsal	11.3	12.0	12.4	14.0	15.0
Length of dorsal spine	8.5	9.0	9.5	10.0	10.5
Length of pectoral.. ..	12.0	11.5	12.0	13.4	15.2
Length of pectoral spine	10.0	10.0	10.0	11.0	12.0
Length of ventral	9.0	10.0	11.0	12.0	12.5
Longest ray of anal	11.0	11.5	10.4	10.8	11.8
Length of base of anal	8.5	8.0	9.0	11.0	12.5
Length of base of adipose dorsal	21.0	17.8	22.8	24.0	30.5

EXPLANATION OF PLATE I.

Indian species of *Gagata* Bleeker.

Gagata gagata (Hamilton).

- FIG. 1.—Ventral surface of head and anterior part of body. *Nat. Size.*
FIG. 2.—Dorsal surface of head and anterior part of body. *Nat. Size.*

Gagata itchkeea (Sykes).

- FIG. 3.—Ventral surface of head and anterior part of body. $\times 2$.
FIG. 4.—Dorsal surface of head and anterior part of body. $\times 2$.

Gagata cenia (Hamilton).

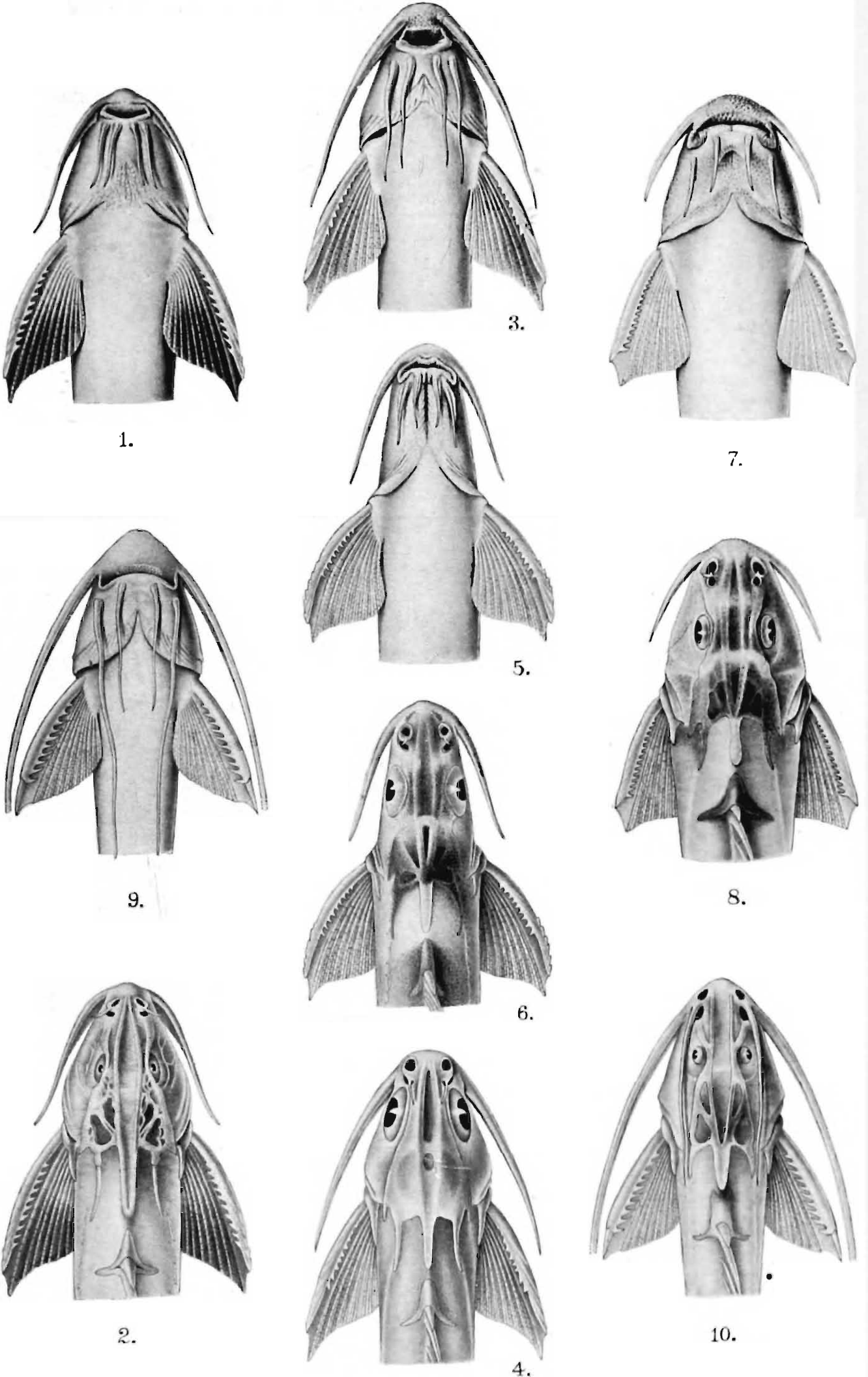
- FIG. 5.—Ventral surface of head and anterior part of body. $\times 1\frac{1}{2}$.
FIG. 6.—Dorsal surface of head and anterior part of body. $\times 1\frac{1}{2}$.

Gagata viridescens (Hamilton).

- FIG. 7.—Ventral surface of head and anterior part of body. $\times \frac{5}{8}$.
FIG. 8.—Dorsal surface of head and anterior part of body. $\times \frac{5}{8}$.

Gagata nangra (Hamilton).

- FIG. 9.—Ventral surface of head and anterior part of body. $\times 3$.
FIG. 10.—Dorsal surface of head and anterior part of body. $\times 3$.



EXPLANATION OF PLATE II.

Indian species of *Batasio* Blyth.

Batasio tengana (Hamilton).

FIG. 1.—Lateral view of a specimen from Duars, Eastern Himalayas.
×1 $\frac{1}{3}$.

FIG. 2.—Ventral surface of head and anterior part of body of same.
×1 $\frac{2}{3}$.

FIG. 3.—Dorsal surface of head and anterior part of body of same.
×1 $\frac{2}{3}$.

Batasio batasio (Hamilton).

FIG. 4.—Lateral view of a specimen from Duars, Eastern Himalayas.
×1 $\frac{1}{3}$.

FIG. 5.—Ventral surface of head and anterior part of body of same.
×2.

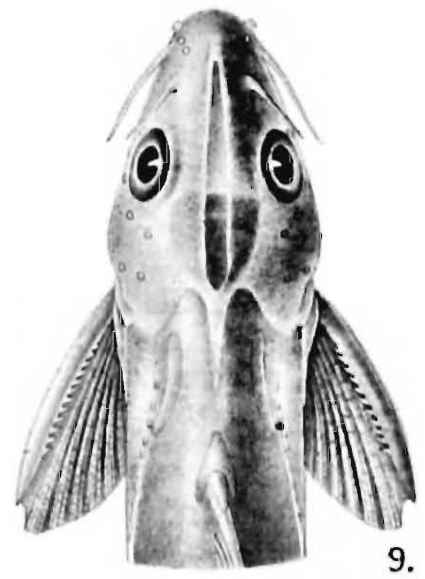
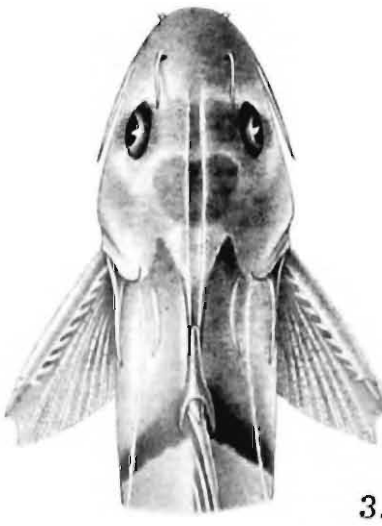
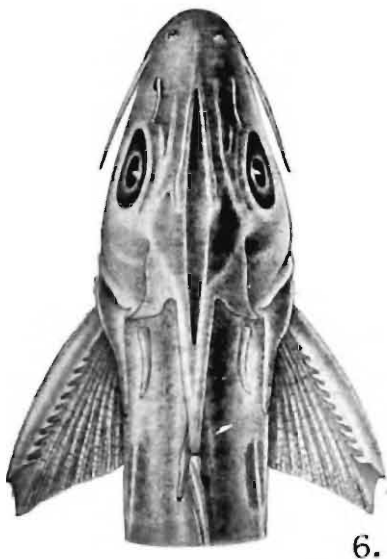
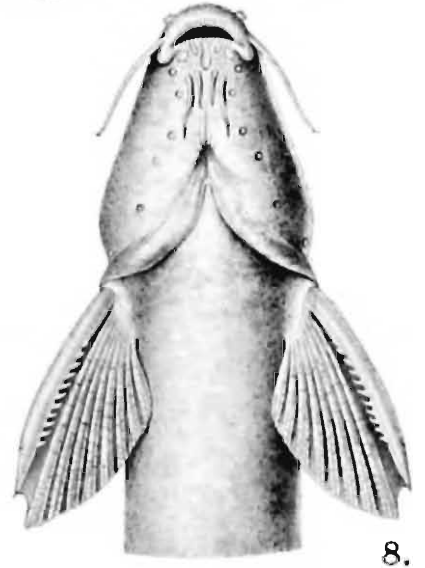
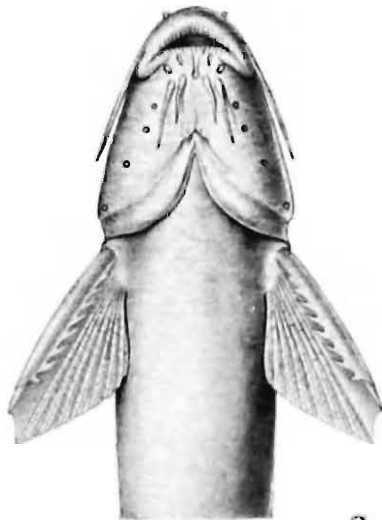
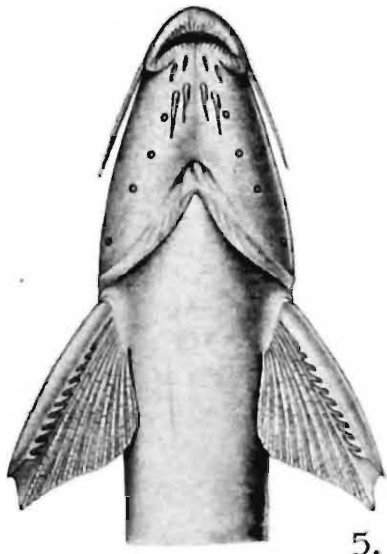
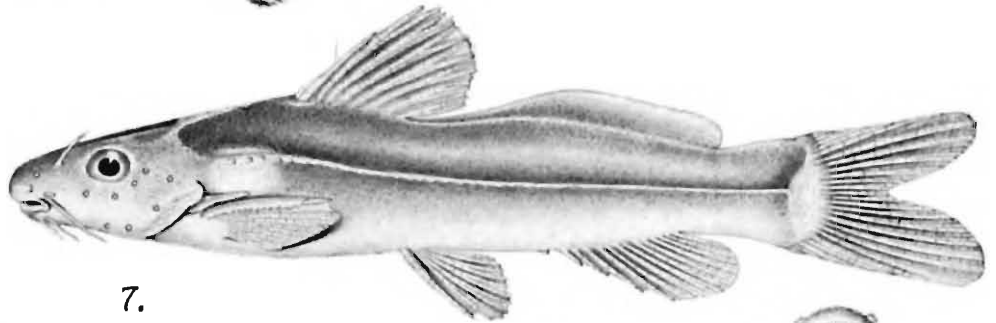
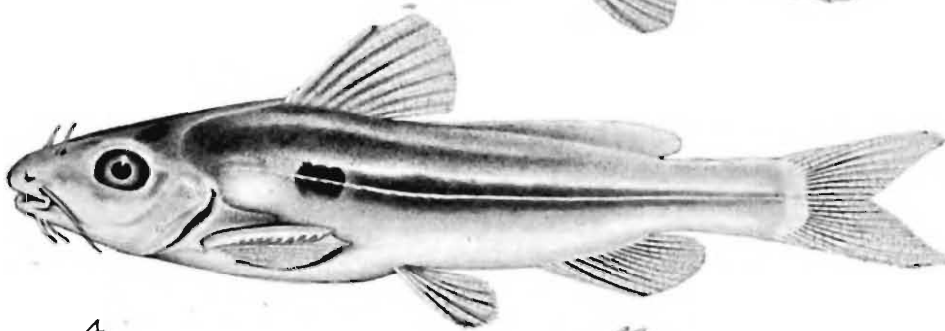
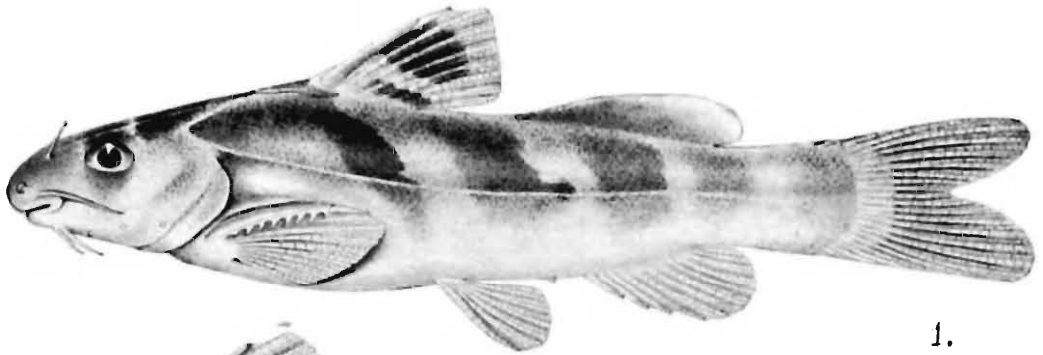
FIG. 6.—Dorsal surface of head and anterior part of body of same.
×2.

Batasio travancoria, sp. nov.

FIG. 7.—Lateral view of type-specimen. *Nat. Size.*

FIG. 8.—Ventral surface of head and anterior part of body of same.
×1 $\frac{2}{3}$.

FIG. 9.—Dorsal surface of head and anterior part of body of same.
×1 $\frac{2}{3}$.



A. K. Mondal del.

Indian species of *Batasio* Blyth.

OBSERVATIONS ON A NEW GREGARINE, *STYLOCEPHALUS*
BAHLI, SP. NOV. FROM THE ALIMENTARY CANAL OF AN
INDIAN BEETLE, *GONOCEPHALUM HELOPIOIDES* FRM.

By P. L. MISRA, *M.Sc.*

(Zoological Research Laboratory, University of Lucknow.)

(Plate III.)

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INTRODUCTION.

In October 1938, while examining the alimentary canal of the common beetle *Gonocephalum helopioides*, I found that it was heavily infested by a gregarine belonging to the genus *Stylocephalus*¹ which has so far not been recorded from India. A study of the structure and life-history of this gregarine presented several features in which it differs from other species recorded so far, and I have therefore instituted for

¹ As the name *Stylorhynchus* was pre-occupied, *Stylocephalus* has been substituted for it by Ellis (1912).

this gregarine a new species, which I have associated with the name of my Professor Dr. K. N. Bahl of the Lucknow University.

MATERIAL AND METHODS.

From October to March specimens of the beetle *Gonocephalum helopioides* were collected from the University grounds at Lucknow, but during May and June they were found only in moist places, *e.g.*, under shrubs on the banks of the river Gumti. During the rains they become scarce but can be found in hollows of trees and in heaps of cattle dung.

After removing the elytra and clipping off the head and the posterior end of the abdomen, the entire gut was removed from the posterior end. The parasites are sometimes seen even without opening the gut, particularly in starved specimens. The gametocysts are also easily detected within the intestine and the rectum. For making smears the gut was teased in a drop of normal saline solution, the parasites taken out, dried in air for a couple of minutes and fixed in Schaudinn's fluid (half an hour), Carnoy's mixture (five to ten minutes), Sublimate-acetic (seven to twelve minutes) or Bouin's fluid (two to three hours). Ehrlich's haematoxylin, Delafield's haematoxylin and Mann's methyl-blue-eosin were used as stains for the smears. The gametocysts were fixed in the same fixatives and stained in Heidenhain's iron-alum haematoxylin. For sectioning, the gametocysts were fixed in Dobell's modification of Bouin's fluid (one hour on the paraffin bath and twenty-three hours at the room temperature), sectioned at 1-3 μ and stained with iron-alum haematoxylin. Liver tissue was tried as a support but it did not prove satisfactory. I therefore injected the cysts by means of a fine pipette into a piece of mid-gut. It is not essential to tie the cut-ends of the gut. At first, a certain quantity of the fixative was injected into the gut to avoid the action of the gastric juice upon the spores in those cases in which the cyst had automatically ruptured and the spores had come out, and then by a careful manipulation, the cysts or the chains of spores with the cystic wall could be lodged within the mid-gut, which was itself immersed into the fixative. To study the endogenous stages of development, the infected gut was fixed in Brasil's modification of Bouin-Duboscq fluid, Dobell's modification of Bouin, Sublimate-acetic (acetic acid four per cent.) and Gilson's mixture. Washing, dehydration and clearing were carried out in the usual way and paraffin was used as imbedding medium. Sections were cut 2-6 μ thick and were stained with Heidenhain's haematoxylin or its modification by Dobell and counter-stained with eosin, Orange-G, Van Gieson's picro-säurefuchsin and Chromotrop 2 R. Giemsa's stain and Mallory's triple stain were also tried but they did not yield good results. Of all the preparations I find that those fixed in fixatives containing picric acid and stained with Heidenhain's haematoxylin and Chromotrop 2 R gave by far the best results.

“Culture” of the cysts:—The gametocysts could easily be collected from the faecal matter of the host (their detection being facilitated by using a piece of black paper or black porcelain background) by soaking the faeces in water and pipetting off the cysts. After washing thorough-

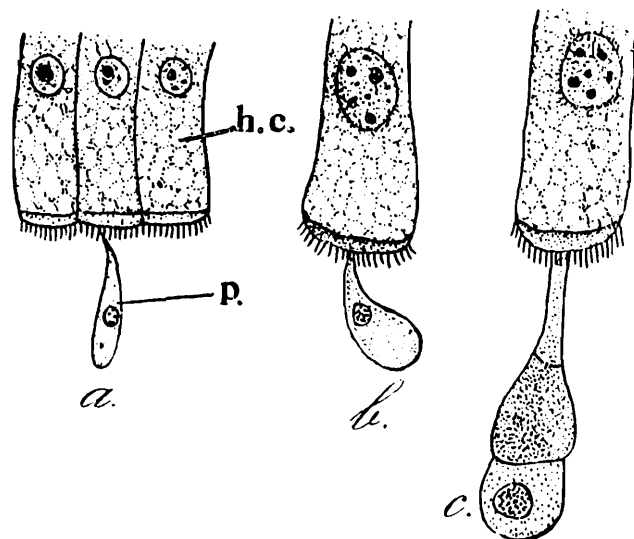
ly in distilled water, the cysts were kept in a drop of normal saline on a coverslip which was inverted upon a cavity slide and placed in a moist chamber. Observations upon cysts in these hanging drops were recorded every fourth hour and cysts at particular stages were fixed for further examination.

Other methods, for example, those adopted for studying the movement of the gregarine, the effect of certain acids and alkalis upon movement, the movement of microgametes, etc., are dealt with in their respective places in the text.

THE LIFE-HISTORY OF *STYLOCEPHALUS BAHLI*, SP. NOV.

(a) *Development of the young trophozoite.*

After its liberation inside the lumen of the gut of the host the sporozoite makes its way towards an epithelial cell, secures an attachment by penetrating its rostral end (text-fig. 1a) into the cell-wall and commences its development at the expense of the nutrient material of the parasitised cell. The cause of the diffuence of the parasitised cell-wall still remains undetermined although it is generally held that certain toxins produced by the sporozoite are responsible for it. Léger and Duboscq (1903) have described and figured intra-cellular development in *Stylorhynchus longicollis*, in which the sporozoite makes its way into the cell, grows inside it for a certain duration and then evaginates, after which it remains attached to the host-cell as a cephalont. In



TEXT-FIG. 1.—a. A sporozoite of *Stylocephalus bahli* attached to an epithelial cell of the host's gut : $\times 1500$. b, c. Developmental stages of the trophozoites : $\times 1500$.

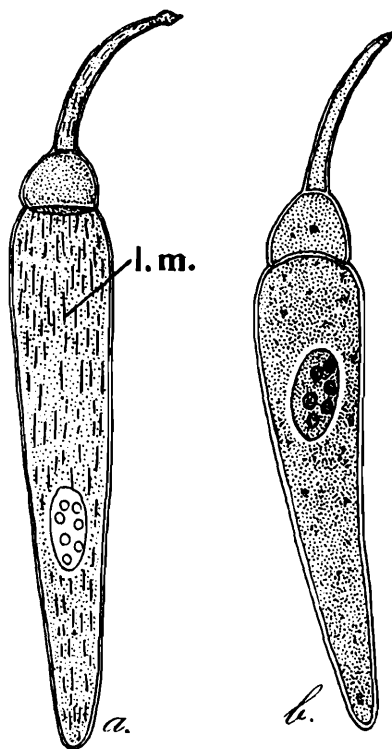
h.c., host-cell ; *p.*, parasite.

Stylocephalus bahli, however, no intra-cellular stage could be seen. The parasite grows all the time extra-cellularly. The rostrum of the parasite within the cell-wall forms primarily an attaching organ, the

epimerite (text-fig. 1 *b*, *c*). Later, this function of attachment is, in all probability, superseded by its capacity to absorb the nutrient material out of the host-cell because as growth proceeds the parasitised cell becomes completely disfigured. The youngest trophozoite I could come across measured $15\ \mu$ in length and showed faint indications of compartments (Pl. III, fig. 1). As growth proceeds, the compartments become well-defined into epi- proto- and deuto-merites. In younger stages the protomerite is longer than the deutomerite and possesses a comparatively denser cytoplasm. Later, however, the deutomerite becomes enormously dilated and further growth leads to its prolongation, whereby it remains widest immediately behind the septum and tapers gradually towards its posterior extremity. At this stage the host-cell becomes degenerate having its nucleus more or less crumpled and its cytoplasm less dense than that of a normal cell.

(*b*) *The structure of an adult trophozoite.*

The body of a full-grown trophozoite (text-fig. 2 *a*, *b*) is elongated and is divided by septa into epi- proto- and deuto-merites. The epimerite is a hollow, tube-like structure, consisting of two parts: (1) a

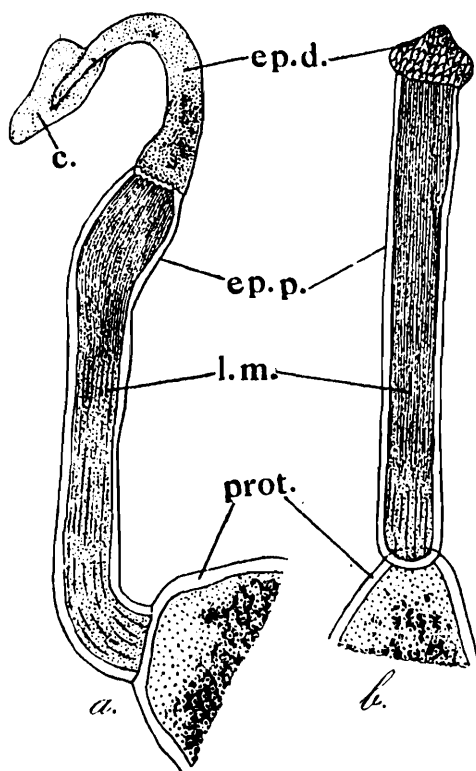


TEXT-FIG. 2.—*a*. An adult cephalont of *S. bahli* examined *in vivo*: $\times 150$. *b*. A cephalont fixed in alcoholic Bouin and stained with Heidenhain's haematoxylin: $\times 168$.

l.m., longitudinal myonemic striations.

proximal and (2) a distal, agreeing in this respect with the epimerite of *S. gladiator* (Blanchard) Watson, but differing from all the other

species of this genus. The distal part is a tongue-like process which remains in intimate contact with the host-cell (text-fig. 3 *a*); when torn apart from its moorings, a crown-like fringe—the torn parts of the host-cell—comes off along with it and obscures the details of its structure. Only rarely could an epimerite be secured, in which its distal end did not carry the remains of the parasitised cell, and in such a case a minute ring could be identified at its extreme distal end. In certain cases well-defined protruberances could be noticed at the end of the epimerite when it was in a contracted condition (text-fig. 3 *b*). The proximal part is retractile and hyaline in appearance. Several longitudinal fibrillae (text-fig. 3 *a, b*; *l.m.*) are seen running along the whole length of the proximal portion of the epimerite to which they impart its power of retractility.



TEXT-FIG. 3.—*a*. Portion of a freshly detached cephalont of *S. bahli*: $\times 850$. *b*. Showing contracted distal portion of the epimerite: $\times 850$.

c., torn off portion of the parasitised cell; *ep. d.*, distal portion of the epimerite; *ep. p.*, proximal portion of the epimerite., *l.m.*, longitudinal myonemes; *prot.*, a portion of the protomerite.

The protomerite of an adult trophozoite is typically broader than long and is conical or sub-conical in shape. Thus it differs from that of the other species of *Stylocephalus*. It is separated from the deutomerite by a fairly thick septum forming a distinct constriction. The cytoplasm has the same characters as those of the deutomerite (*vide infra*) except that it is less dense and does not contain big granules. Sometimes patches of chromatin material are present in its substance. The following tables give the measurements showing the ratio of the length of the protomerite to the total length and also the ratio of its width to that of the deutomerite.

TABLE 1.—*Showing the ratio of the length of the protomerite to the total length of the body.*

Length of the protomerite (L. P.) in microns.	Total length of the body (L. T.) in microns.	Ratio of the length of the protomerite to the total length (L. P. : L. T.).
20	160	1 : 8
20	900	1 : 45
30	162	1 : 5.4
40	1,010	1 : 25.2
48	1,008	1 : 21
50	1,045	1 : 20.9
58	1,054	1 : 18.1
66	896	1 : 13.5
75	1,100	1 : 14.6
75	1,100	1 : 14.6
Average L. P. : L. T. :: 1 : 18.63		

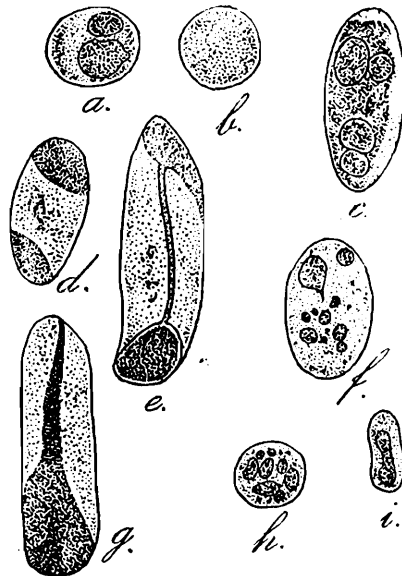
TABLE 2.—*Showing the measurements and ratios of the width of the protomerite to the width of the deutomerite.*

Width of the protomerite (W. P.) in microns.	Width of the deutomerite (W. D.) in microns.	Ratio of the width of the protomerite to the width of the deutomerite. (W. P. : W. D.)
20	30	1 : 1.5
60	76	1 : 1.2
66	91	1 : 1.3
66	91	1 : 1.3
72	120	1 : 1.6
72	120	1 : 1.6
83	94	1 : 1.1
83	132	1 : 1.5
83	132	1 : 1.5
33	40	1 : 1.2
Average W. P. : W. D. :: 1 : 1.38.		

The deutomerite is the largest segment of the body and is circular in cross-section. It is broadest immediately behind the septum and

gradually tapers towards the posterior end but is never sharply pointed. The pellicle is 2.5μ in thickness. Epicytial longitudinal striations are very clearly discernible in the living condition (text-fig. 2 *a*). The cytoplasm of the deutomerite consists of a semi-fluid matrix, charged with numerous granules of a brownish colour, some of which are fairly large in size. In between these granules there are often certain other granules which are smaller in size and appear pinkish in colour by reflected light. Usually with strong fixatives the general appearance of the cytoplasm appears entirely different from that in the living condition.

In the living condition the nucleus in the deutomerite appears as a translucent area situated anywhere between the septum and the posterior end of the body. Actually it moves from one place to another following the streaming movement of the protoplasm, but its speed is much slower than that of the cytoplasmic current. Further, it may not make a complete circuit but may make a short cut and come back



TEXT-FIG. 4.—*a-i*. Nuclei of *S. bahli* showing various types of accumulations of the chromatin material: $\times 850$.

to the position from which it started. How its movement is controlled is not clear. Ray and Chakravarty (1933) have mentioned a "system of tethering threads" attached to the concave surface of the half-moon-shaped nucleus of *Monoductus lunatus* and maintain that the contractions and relaxations of these threads are responsible for determining its shape and position in the deutomerite. No such arrangement for adjusting its location could be detected in the nucleus of *Stylocephalus bahli*, and the change of its position, presumably, appears to be passive.

The nucleus is very variable in size, shape and structure. In a young cephalont it is spherical, subspherical or ellipsoidal in shape and its size is comparatively bigger in relation to the body as compared with that of the adult forms. A normal full-grown nucleus is always ellipsoidal and measures on an average $57.5 \mu \times 35 \mu$. It has a distinct nuclear membrane surrounding the nucleoplasm in which several karyosomes are clearly discernible in the living condition (text-fig. 4 *c, f, h*). Their number varies from two to ten. The nuclear

membrane takes a deep stain with iron-haematoxylin and appears to be chromatinic in character. In certain cases its boundary was seen to be irregular and shrunken, but this seems to be due to the effect of fixation. The nucleoplasm does not appear uniform in character, certain portions being denser and more granular and exhibiting a stronger affinity for chromatin stains than the others. Sometimes, however, probably prior to nuclear division, the karyosomes were seen to be absorbed and the chromatin masses accumulated at the two ends of the nucleus (text-fig. 4 *d*). These two darkly stained areas might get connected by a thin strand which also stained deeply with chromatin dyes (text-fig. 4 *e*). Further, the accumulation of the chromatin mass might be on one side only, presenting thereby a "geflammte" appearance inside the nucleus (text-fig. 4 *g*), or there might be an intermediate condition between these two extremes, *i.e.*, at one end the accumulation would be very dense and at the other very faint. The significance of these variations in the arrangement of the chromatinic substance in the nucleus is not clear.

(c) *The sporonts.*

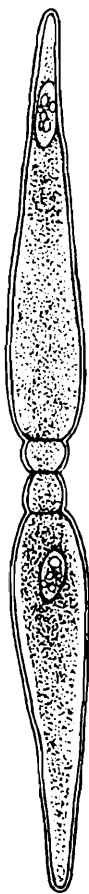
The sporonts can be distinguished from the cephalonts by the absence of the epimerite and by their being charged with greater quantity of reserve granules, which lend the cytoplasm a dark-blue appearance. Further, the sporonts are more inert than the cephalonts as regards locomotion. The sporonts of *S. bahli* are characteristically solitary and measure 200-2000 μ in length. The ratio of the length of the protomerite to the total length in an individual of maximum size is 1 : 37.5. The protomerite is broader than long and the ellipsoidal nucleus lies in the elongated deutomerite, which in its general outline is of the same shape as that of the adult trophozoite. After moving solitarily for some time the sporonts generally unite in pairs and encyst.

As regards the detachment of the epimerite from the protomerite at the time of the formation of the sporont, previous workers have expressed different opinions. For example, Duke (1910) says, "Just at the line of junction between the protomerite and epimerite a bubble-like vacuole appears, which gradually increases in size. .. Having reached a diameter about equal to that of the protomerite the vacuole bursts, and the gregarine is suddenly deprived of its epimerite" Further she says, "This vacuole-formation. .. in my opinion has a probable bearing on the mooted question regarding the fate of the gregarine epimerite, in the transition from cephalont to sporont." Thus she means that vacuole-formation causes detachment of the epimerite. On the contrary, my observations on *Stylocephalus bahli* prove that the formation of a bubble at the hind end of the detached epimerite and the front end of the protomerite is an after-effect of detachment rather than its cause, and is due to the interaction between two dissimilar media, the saline solution and the cytoplasm. Personally, I believe that it is normally the ageing and its effect on metabolic activities which are responsible for the separation of the epimerite. Léger and Duboscq (1902) have also recorded vacuole-formation in *Pyxinia mo-*

buszi. Frenzel¹ in his observations on several cephalonts, came across some individuals with only a small projection which represents the epimerite on the protomerite; he concludes that the epimerite slowly degenerates and is absorbed in the same way as a tadpole's tail is absorbed during metamorphosis. A sudden disappearance of the epimerite, according to him, is pathological. Lühe (1904) is of opinion that the falling off of the epimerite is a typical method of cephalonts becoming free. My observations on *S. bahli* coincide with those of Frenzel as I have seen extruded and the so-called absorbed epimerites in the same smear. The variable lengths in the epimerites of *S. bahli* at least are not due to their varying degrees of absorption, but to their degree of retractility. It was noted that when teased the epimerites, either by contact with needles or by the strain imposed upon them by setting apart from their host-cells, retracted partially or wholly, and it is this power of retractility which is responsible for the variations in the lengths of the epimerites.

(d) *Association.*

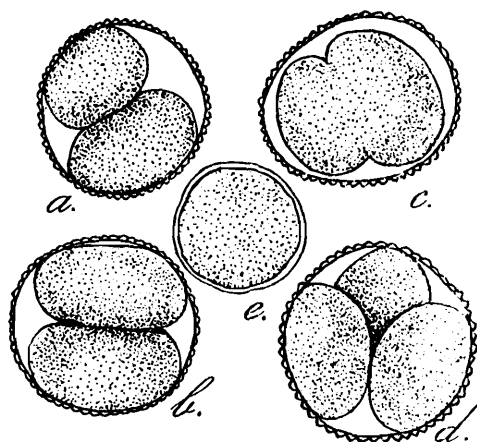
(i) *Normal association.*—Two mature sporonts first associate by their anterior ends (text-fig. 5) forming a pair which keeps moving



TEXT-FIG. 5.—Sporonts of *S. bahli* in association : $\times 190$.

¹ As quoted by Duke, H. L., *Quart. Journ. Micros. Sci.* LV, p. 268 (1910).

for some time and then the two begin to approach closer and closer by their posterior ends and ultimately round off in a common cyst secreted from their outer surfaces (text-fig. 6 *a, b, c*). While rounding a process of concentration of cytoplasm takes place as is evinced by the diameter of the cyst which becomes much less than the length of the associates. In due course, elevations arise on the cystic wall forming numerous pointed, chitinoid protuberances. An examination of



TEXT-FIG. 6.—Gametocysts of *S. bahli* seen in fresh faecal matter: $\times 90$.

a-c. represent normal association; *d.*, a triple association; *e.*, single individual encysted and devoid of chitinoid protuberances on the cystic wall.

freshly formed cysts revealed that the contained gametocytes are either of the same or of unequal size (text-fig. 6 *a, b*). This inequality of size indicates sexual differentiation of the sporonts. Still more cogent and convincing proof of sex-differentiation, however, becomes available on an examination of permanent preparations of these cysts in which nuclear division has taken place (Pl. III, fig. 7). The nucleus of the male gametocyte divides earlier and with greater rapidity than that of the female. Thus, dissimilarity begins at this stage and leads to an undoubted case of anisogamy, in which the male contains only the motile microgametes and the female non-motile macrogametes.

As regards unequal gametocytes encysting together in a common cyst, Woodcock (1906) says, "Probably, in any case, the associates require to be of about equal age and size if the union is to be successful." Berndt (1902) says that no true cyst-wall is formed in those cases of syzygy in which the members are of considerable difference, and ultimately they die off. Siedlecki, Léger and Brasil have quoted examples where the sporoblasts have been produced by one member of the couple in the usual manner, the other remaining stationary and ultimately dying off. Further, Woodcock (1906) says: "One gregarine of a couple can in certain cases, apparently, exert sufficient influence upon its associate to induce it to commence sporulation, although it itself may not be ripe enough to do so and as a result not only does it not benefit by the stimulus or "Reiz" of the other, but, this on the contrary, appears to harm it and it succumbs instead." My observations on *S. bahli* do not absolutely conform with the views and observations of the authors mentioned above. No doubt cysts containing unequal associates can be seen to disintegrate at times, but the dis-

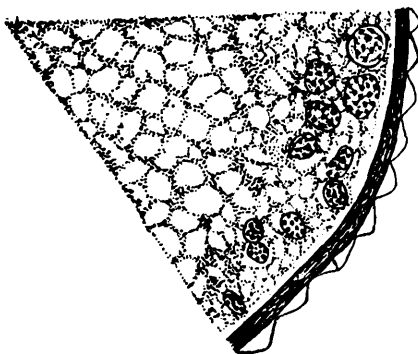
integration is not confined to them only. Couples of equal sizes have also been seen by me to disintegrate, probably on account of certain inhibitory factors. The formation of gametes, their mutual fusion, zygote- and spore-formation was clearly noted even in those cases where one member of the couple was approximately half in diameter as compared with its partner. Nuclear division was, however, set up earlier in the smaller member and microgametes were formed out of its substance indicating that it was really the microgametocyte. The only difference that could be detected in cases of unequal association lay in the size of the residual cytoplasm of the gametocyst which in this case was smaller in comparison to that found in equal but fully matured associates. Usually, the normal gametocysts measure $208\ \mu$ — $352\ \mu \times 80\ \mu$ — $320\ \mu$ and are spherical, sub-spherical, or egg-shaped in appearance (text-fig. 6 a, b, c).

(ii) *Abnormal association and encystment*.—Not infrequently some gametocysts taken from the faecal matter within the rectum or outside were found to possess three individuals encysted together (text-fig. 6 d). Such abnormal cysts have already been recorded by Kunstler (1892) in *Diplocystis schneideri*, Cuénot (1901) in *Diplocystis* sp., Berndt (1902) in *Gregarina cuneata*, Woodcock (1906) in *Cystobia irregularis*, Cunningham (1907) and Robinson (1910) in *Kalpidorhynchus arenicolae*, Bastin (1919) in *Monocystis agilis*, Mary Vincent (1922) in *Pyxinia anobii*, Bhatia and Setna (1926) in *Monocystis matthai*, and Setna and Bhatia (1934) in *Hirmocystis parapeneopsis*. Cuénot has recorded instances of triple association, which are very rare, in *Diplocystis*, one of which had apparently produced sporoblasts; but Woodcock (1906) remarks, "Judging from his (Cuénot's) fig. 47, however, sporulation would not seem to have been successful, the sporoblasts being extremely minute and scarcely visible, very different from the well-developed layer in the normal cysts figured" Bastin has seen similar abnormal cysts of *Monocystis agilis*, and was able to notice the formation of gametes. Bhatia and Setna have detected fully-developed spores in a case of triple association in *Monocystis matthai* and thus have supported Cuénot's and Bastin's observations. On no occasion could I observe in the triple association of *S. bahli* either complete gamete-formation or any other advanced stage of sporulation. Only twice nuclear divisions were seen to have taken place partially in two out of the three associates, but in all cases they ultimately degenerated.

Encystment of a single individual has also been encountered at times by watching mature sporonts in saline on a slide. After moving for some time the sporont becomes less vigorous, contracts gradually, till it becomes globular and then secretes a wall round itself (text-fig. 6 e). The whole process takes from one-and-a-half to four hours when kept in normal saline solution. No protuberances could be seen on the wall of such an encysted individual. Such individuals ultimately perish and in this respect my observations confirm those of Brasil (1905) who recorded a similar fate for solitary encystment in *Gonospora* and *Urospora*. Siedlecki, Cuénot, Berndt, Léger and Cunningham, on the other hand, have asserted that they never encountered cases of solitary encystment.

(e) *Gamete-formation and anisogamy.*

After encystment the nucleus of each gametocyte soon prepares to divide. The nuclear membrane disappears and the chromatin mass becomes comparatively dense. The actual chromosome cycle could not be traced, but it was noticed that the nucleus of each gametocyte repeatedly divides into several daughter nuclei, which subsequently migrate to the periphery (text-fig. 7). This division, as already men-



TEXT-FIG. 7.—Portion of the section of the gametocyst of *S. bahli* showing nuclear migration to the periphery: \times ca. 1000.

tioned, begins and is completed earlier in the male gametocyte than in the female (Pl. III, fig. 7, *m.*, *f.*). The cytoplasm of each gametocyte segments around each nucleus and thus the gametes are formed. The whole process of gamete-formation takes from eight to twenty hours from the time the freshly extruded cysts are kept in the moist chamber. This duration depends chiefly upon temperature, as I find that the period decreases with the rise of temperature, the optimum results having been obtained at 37°C.

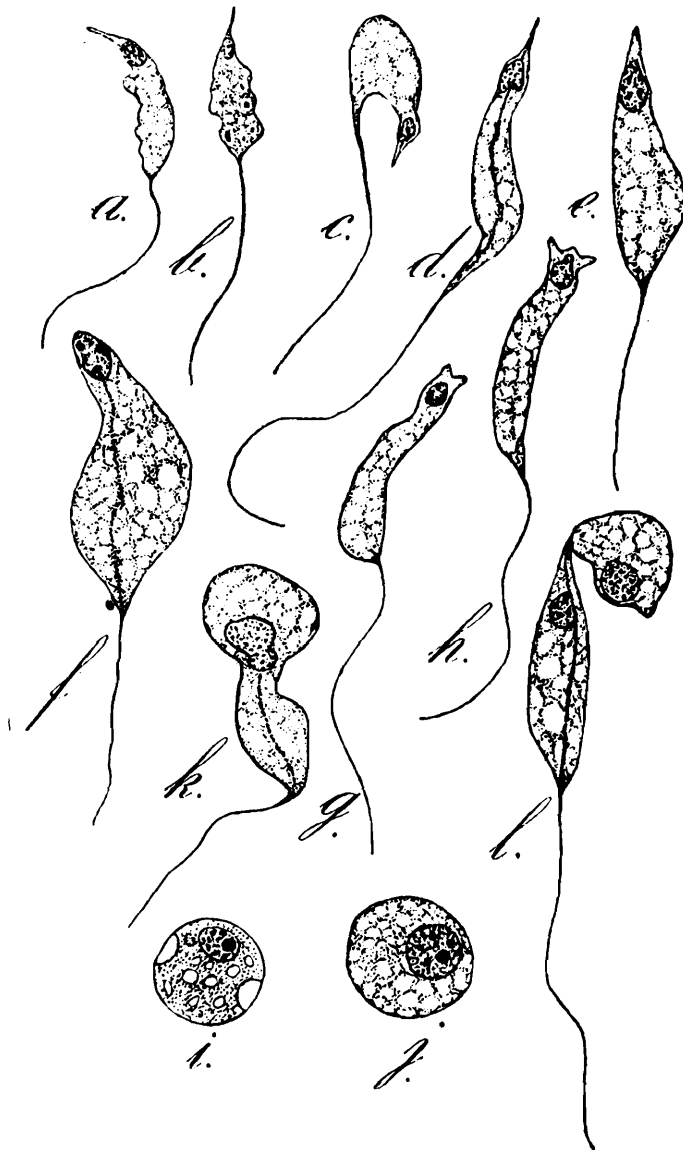
Anisogamy:—An examination of smears obtained by puncturing the mature gametocysts revealed that the gametes could be distinguished into: (i) the microgametes, and (ii) the macrogametes.

(i) The microgametes:—All the microgametes are not of the same kind. On a close examination three types can be distinguished, *viz.*,

- (a) Normal, fusiform, but sterile microgametes.
- (b) Normal, pyriform, fertile microgametes.
- (c) Abnormal microgametes.

A fresh preparation, in a slightly albuminated physiological saline, of a ruptured gametocyst in which gametes have formed, shows that there are two kinds of actively moving microgametes: (i) The first kind of microgametes are fusiform in shape and are fewer in number than (ii) the second type, which are pyriform in shape, 14 to 21 μ in length and more abundant but less active than the first type. The fusiform microgametes have generally two or three prominences (text-fig. 8 *g*, *h*) on the head and are sterile (*vide infra*); while the pyriform microgametes (text-fig. 8 *a-e*) have only one anterior prolongation, the perforatorium on their heads, and are fertile and appear to possess an acute sensitivity for tracing out the receptive spot of the macrogamete (Pl. III, fig. 2, \times).

Fixed and stained preparations revealed the nucleus of the microgametes lying within the head, and containing three to five deeply staining bodies in a homogeneous and faintly staining nucleoplasm. The cytoplasm is vacuolated and granular in character. An axial filament, easily seen to arise from the perforatorium (text-fig. 8 *d, l*), traverses the whole length of the body and continues behind as a whip-like tail, which helps the microgamete in its movement.



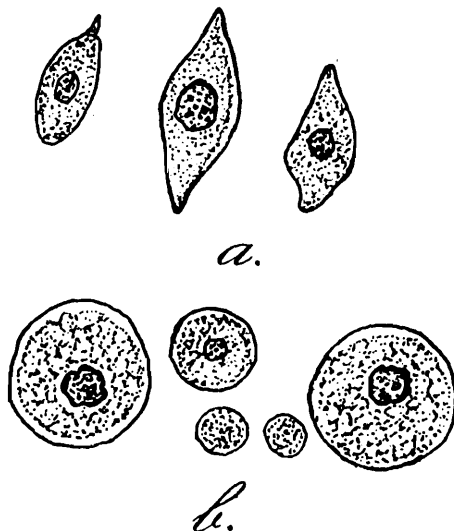
TEXT-FIG. 8.—*a-e*. Normal, pyriform microgametes of *S. bahli* : $\times 1333$. *f*. An abnormal microgamete : $\times 1333$. *g, h*. Fusiform, sterile microgametes : $\times 1333$. *i*. A macrogamete : $\times 1750$. *j*. An abnormal macrogamete : $\times 1750$. *k*. Fusion of a microgamete with a macrogamete : $\times 1750$. *l*. A microgamete attached to a zygote : $\times 1375$.

Further, abnormal microgametes (text-fig. 8 *f*) have also been encountered. These are distinguished by their bigger size, blunt anterior end and a fairly stout and stumpy posterior tail. They degenerated ultimately.

(ii) The macrogametes :—They are more or less spherical bodies, measuring 6μ to 8μ in diameter. The spherical nucleus is 2μ in diameter with a well-marked nuclear membrane ; it possesses an eccentrically placed karyosome and four or five chromatoid bodies (text-fig.

8 *i*). The cytoplasm is very much vacuolated and is packed up with reserve granules. There are two thin, hyaline areas at the periphery forming receptive spots, which permit as well as facilitate the entrance of the microgametes. Sometimes, abnormal macrogametes (text-fig. 8 *j*), comparatively bigger than the normal ones, were also met with in some of the preparations.

Degenerating gametes:—Some preparations revealed small bodies which on closer examination proved to be degenerating gametes of varying sizes. Tail-less, spindle-shaped bodies with crumpled nuclei

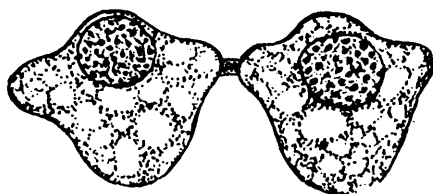


TEXT-FIG. 9.—*a*. Degenerating microgametes : \times ca. 2800. *b*. Degenerating macrogametes : \times ca. 2800.

were apparently degenerating microgametes (text-fig. 9 *a*), while other bodies (text-fig. 9 *b*) in which the nucleus had shrunk and the cytoplasm contracted, with a consequent decrease in size were recognised as the degenerating macrogametes.

(*f*) *Fertilisation and spore-formation.*

Coupling of the gametes takes place after the dissolution of the partition between the male and the female chambers when the microgametes rush towards the macrogametes. All the microgametes however, do not go into the female chamber, but there is a displacement of the macrogametes from the female chamber into the male chamber, with the result that coupling can be observed simultaneously in both the compartments. The microgametes agitate violently to and fro, and as soon as they come in contact with suitable partners, mating takes place quickly. The fertile microgametes generally pierce through the receptive spots (Pl. III, fig. 2, \times) of the macrogametes, only one finding entrance into the body of the latter. The nucleus of the microgamete

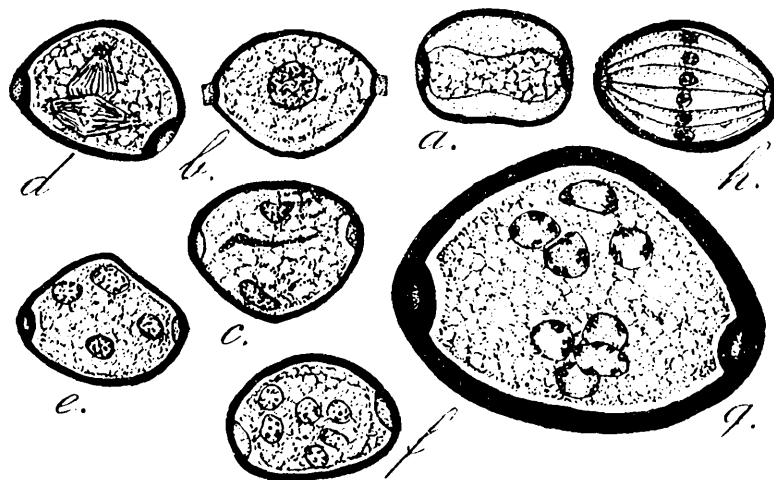


TEXT-FIG. 10.—Two zygotes of *S. bahli* attached with each other : \times 4000.

approaches that of the macrogamete and fuses with it (text-fig. 8 *k*). It takes two to eight minutes for a microgamete to fuse completely with the body of the macrogamete. The act of fertilisation being thus accomplished, the fertilised macrogamete or the zygote slightly elongates (text-fig. 10), secretes a wall around it and becomes a spore (text-fig. 11 *a, b*). While examining a fresh preparation in which the microgametes were still moving within the cyst, it was found that the fertilised macrogametes became gradually arranged in chains; sometimes enchainment of even unfertilised macrogametes also takes place, in which case the microgametes could be seen making their way into the chains and fertilising the macrogametes there. Some microgametes were observed to remain active from six to fourteen hours after the complete enchainment of spores. These were, no doubt, mostly the sterile microgametes, which later on degenerate. The duration of complete sporulation was noted to be 48-60 hours.

(*g*) *Structure of the spores and formation of the sporozoites.*

The hat- or pouch-shaped spores (text-fig. 11 *a, b*) measure $11 \times 7.5 \mu$, and are arranged in chains which show a coiling tendency if de-



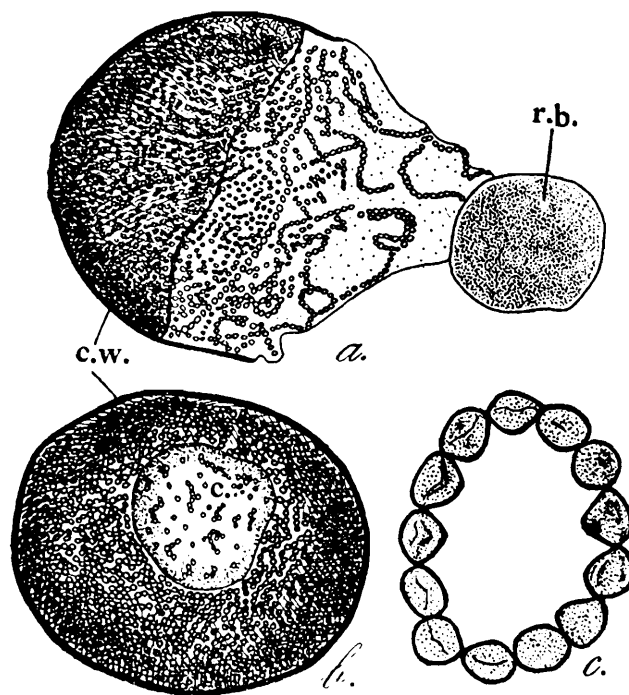
TEXT-FIG. 11.—*a, b*.—Spores : $\times 1727$. *c-f*. Spores showing nuclear division : $\times 1727$. *g*. A spore with eight nuclei : $\times 3454$. *h*. A mature spore with sporozoites : $\times 1727$.

tached away from the cyst. The cystic wall is 0.5μ thick. It is brownish in colour and becomes almost black after the formation of sporozoites. The cytoplasm of the spore is alveolar in appearance and possesses a marked affinity for chromatin stains, indicating the presence of chromatoid granules in it. The nucleus of the spore soon divides mitotically into two (text-fig. 11 *c*), the plane of division being at right angles to the long axis of the spore. The two daughter nuclei again divide mitotically into two each, and thus a quadri-nucleate stage is reached (text-fig. 11 *d, e*). At this stage, any two of the four may divide first whereby a six-nucleate stage (text-fig. 11 *f*) can be made out, or all the four may divide simultaneously and form eight nuclei (text-fig. 11 *g*). The latter seems to be the general tendency. At this stage, the chromatin of the daughter nuclei remains concentrated in patches at the periphery and the rest of the nucleoplasm stains faintly. The cytoplasm of each spore segments around the nuclei in such a way that the

segmented bodies, *i.e.*, the sporozoites lie parallel to each other along their long axes and also parallel to the long axis of the spore (text-fig. 11 *h*). Moreover, when viewed laterally, the nuclei of the sporozoites are arranged in a line, at right angles to the length of the sporozoites. Typically the sporozoite is spindle-shaped and measures $10\ \mu$ in length and $2\ \mu$ in width at its widest central region. Its cytoplasm is homogeneous, while the centrally situated nucleus is more or less spherical and possesses four or five deeply staining granules.

(*h*) *Dehiscence.*

After spore-formation, the residual cytoplasm acquires a wall around it forming a pseudocyst which under favourable conditions of warmth and moisture, swells up and causes the rupture of the cyst. The residual cytoplasm, thus, seems to be hygroscopic in nature. The rupture of the cyst is at times so violent as to liberate not only the spores but



TEXT FIG. 12.—*a.* A ruptured cyst showing the chains of spores: $\times 46$. *b.* A gametocyst in which a lid-like portion has cleft apart leaving an outlet for the spores: $\times 188$. *c.* A chain of spores magnified: $\times 500$.

c., cavity; *c. w.*, cystic wall; *r. b.*, residual body.

also to throw out the cystic residue (text-fig. 12 *a*). On certain occasions, however, it was found that a well-defined lid was thrown off and the spores came out of it (text-fig. 12 *b*). At other times, it was observed that the cystic residue disintegrated and the dehiscence of spores, in such cases, was caused by a simple rupture, presumably caused by the pressure of the fluid formed by the dissolution of the cystic residue,

(i) *Probable mode of infestation.*

Infestation is purely accidental and involves only a single host to complete the life-cycle. When the host, *Gonocephalum helopioides* takes in food contaminated with infective spores, the sporozoites are liberated into the gut by the action of the gastric juices upon the spores and make their way towards the epithelial cells of the alimentary canal, where they commence their further development.

SEASONAL INTENSITY AND SITE OF INFESTATION.

The host-gut was found heavily infested during winter. The seat of infestation is usually the mid-gut and the intestine, but in cases of heavy infestation the parasites could be found right from the oesophagus to the rectum and in such cases the lumen of the posterior part of the intestine was entirely occluded by them (Pl. III, fig. 8). From March to June, gametocyst-formation is at its best and this process seems to be correlated with the rise of temperature; its optimum effect being during April, May and June. During July and August sporonts are often met with though not in abundance. An increase in the degree of infestation was noted during the latter part of September and reached its climax in October and November. On an average, 97 per cent. of the beetles were infected.

POLYNUCLEARISM.

There is a great divergence of opinion with regard to the occurrence of the phenomenon of polynuclearism in gregarines. Berndt (1902) has recorded the presence of certain patches, which stain darkly with chromatin dyes, specially in the protomerite. Comes (1907) noted similar patches in *Stenophora* and regarded them as metabolic products, not nuclear in origin. Schellack (1907) has reported the occurrence of darkly-staining areas in the epimerite of *Echinomera hispida*, while Duke (1910) detected such patches throughout the body of *Metamera schubergi*. In *S. bahli* one or two patches, having a strong affinity for chromatin stains, were noted in the protomerite as well as in the deutomerite (Pl. III, figs. 4, 5). However, the occurrence of the so-called several nuclei in the body of the gregarines should be regarded as abnormal. As regards their origin it is difficult to make a suggestion, but it is possible that an increase in the nuclear material causes a disturbance in the kern-plasma relation, whereby nuclear extrusion takes place and the diffused chromatin particles flow along with the cytoplasm and ultimately aggregate into definite patches in a particular part or parts of the organism.

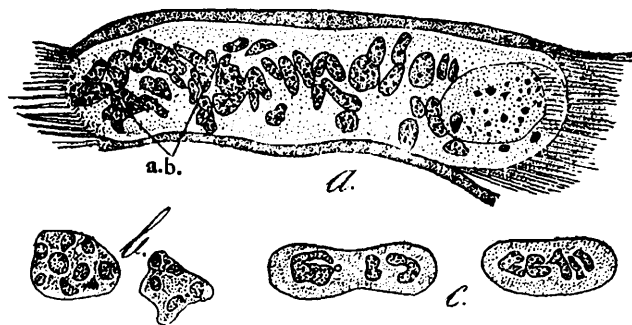
HYPERPARASITISM.

A noteworthy phenomenon of hyperparasitism in *S. bahli* deserves special mention. Under pathological conditions this gregarine appears

to be susceptible to certain infections which may be classed as (a) cytoplasmic, and (b) nuclear.

(a) *Cytoplasmic parasitism*.—A longitudinal or oblique section (Pl. III, fig. 6; text-fig. 13 a) of an infected gregarine after staining with Heidenhain's haematoxylin showed the whole of the cytoplasmic area in the deutomerite having been parasitised by numerous multinucleate amoeboid bodies (text-fig. 13 b)—probably *Metchnikovella*. These could not be diagnosed as no spores were met with. Their exact systematic position needs further investigation.

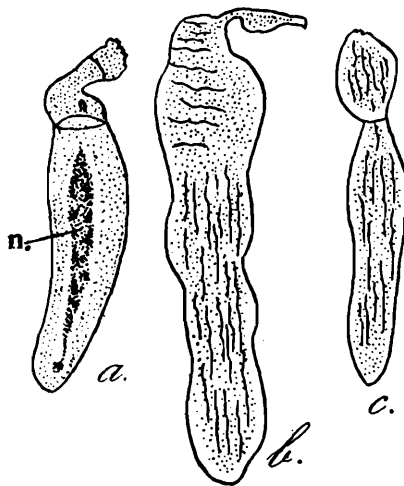
(b) *Nuclear parasitism*.—In certain cases nuclei could be observed to have been infected with a fungus, probably belonging to the family



TEXT-FIG. 13.—a. An oblique section of the parasite showing multinucleate amoeboid bodies in its cytoplasm: $\times ca. 950$. b. Two multinucleate amoeboid bodies magnified: $\times ca. 2300$. c. Two parasitised nuclei: $\times 600$.

a. b., amoeboid bodies.

Chytridiaceae (text-fig. 13 c). The infection seems to begin at the centre of the nucleus, and to proceed to the periphery, thereby causing a dis-



TEXT-FIG. 14.—a. A cephalont of *S. bahli* showing degenerating parasitised nucleus (n.): $\times 90$. b, c. Degenerating individuals in which the nucleus has vanished: $\times 65$.

solution of the nuclear membrane (Pl. III, fig. 3). The infected nucleus gradually degenerates, and the gregarine loses its metabolic activities, till at last it perishes (text-fig. 14 a-c).

EFFECT OF THE PARASITE UPON THE HOST.

In spite of the fact that the host is heavily infested, it does not seem to suffer any serious damage. Only the parasitised epithelial cells of the gut-wall undergo some change and appear abnormal on account of a deficiency in their cytoplasmic contents, and sometimes owing to the atrophy of their nuclei. In some cases, where occlusion occurs, the parasites must be inhibiting the passage of food-material from the anterior to the posterior end of the gut of the beetles. But, nevertheless, the host does not succumb, as it is hardy enough to withstand starvation for a long period during which the parasites encyst and pass down to the rectum leaving the passage clear once more for food.

SYSTEMATIC POSITION.

The solitary nature of the sporonts, dehiscence by pseudocyst, spores hat-shaped, brown or black in colour and disposed in chains are characters which assign this gregarine to the family Stylocephalidae Ellis. The epimerite with a dilated papilla at the end of a long slender neck, cysts beset with small papillae and hat-shaped spores determine its assignment to the genus *Stylocephalus*. The species *S. bahli* differs from the hitherto described species of *Stylocephalus* in possessing the following features :—The epimerite is peculiar and consists of two parts : (i) a distal tongue-like portion and (ii) a proximal tubular portion which is hyaline and retractile. In this respect it partially resembles *S. gladiator* (Blanchard) Watson, but differs from the latter in having the apical portion of the epimerite not longer than the rest of the body in the adult condition, and also in possessing a fairly large size ; the maximum size of *S. gladiator* being $720\ \mu \times 70\ \mu$, while that of *S. bahli* is $2000\ \mu \times 98.7\ \mu$. The protomerite of *S. bahli* is broader than long and is conical or sub-conical in shape, hence it differs from others in this respect. Further the nucleus of *S. gladiator* is ovoidal and contains a single karyosome, whereas the nucleus of *S. bahli* is ellipsoidal and contains several karyosomes. Thus it resembles, in this respect, *S. oblongatus* and *S. longicollis*, but differs from them in other respects, e.g., in the shape of the protomerite, the shape of the cyst, the size of the spores, etc.

The following table (on pp. 62 and 63) shows the various points of resemblance and difference between *S. bahli* and other species of this genus which have been previously described.

To sum up, the specific characters of *S. bahli* are as follows :—Sporonts solitary, elongate, maximum size $2000\ \mu \times 98.7\ \mu$; L. P. : L. T. : : 1 : 37.5 in maximum-sized individual ; epimerite elongated, hollow and tubular consisting of a retractile proximal and a tongue-like distal portion ; protomerite conical or sub-conical ; L. P. : L. T. : : 1 : 18.63 ; W. P. : W. D. : : 1 : 1.38 ; deutomerite broadest behind the septum and gradually tapering posteriorly ; pellicle $2.5\ \mu$ thick ; endocyte brown in cephalonts, dark-bluish in sporonts ; nucleus ellipsoidal with several karyosomes ; cysts spherical, sub-spherical or egg-shaped ; dehiscence by pseudocyst or simple rupture ; spores hat-shaped, dark-brown or black, $11 \times 7.5\ \mu$.

Characters.	<i>S. oblongatus.</i>	<i>S. longicollis.</i>	<i>S. brevisrostris.</i>	<i>S. gladiator.</i>
1. Sporonts	Solitary, elongate, maximum length 3000 μ .	Solitary, elongate, measurements not mentioned.	Solitary, stout bodied, maximum size not mentioned.	Solitary, elongate; maximum size 720 μ .
2. Epimerite	A thick cylindrical neck with a terminal dilated portion with papilla on extremity; whole epimerite being one-and-a-half to twice the length of the protomerite alone.	A long slender cylindrical neck terminating in a slightly dilated papillate anterior end; the whole being three or four times the length of the protomerite alone.	A small xiphoid coin-oidal tongue projecting upward from the centre of the protomerite, whole length being equal to half that of the protomerite.	Consists of two parts: (i) a very long slender neck and (ii) a dilated xiphoid-shaped apical portion, often longer than the whole body.
3. Protomerite	Globular, constriction at septum.	Pentagonal in lateral optical view, truncate at apex; slight constriction at septum; width equal to length.	Cylindrical, of nearly equal width throughout, corners rounded at anterior end; no constriction at septum; width equal to length.	Short and globular.
4. Deutomerite	Cylindrical, tapering slightly from middle, ending in a rather slender blunt posterior extremity.	Elongate, cylindrical, tapering in posterior two-thirds and ending in a rather blunt point.	Just below the septum it is a little wider than the protomerite and tapers to a rather sharp point.	Elongate, cylindrical, with a slender attenuated extremity, bluntly pointed.
5. L. P. : L. T.	1 : 6 to 1 : 8	1 : 10	1 : 4	×
6. W.P. : W.D.	1 : 2	1 : 1.1	1 : 1.2	×
7. Nucleus	Ellipsoidal with several karyosomes.	Ellipsoidal with several karyosomes.	Spherical with 6 to 9 small karyosomes.	Ovoidal with one karyosome.
8. Endocyte	Yellowish in cephalons becoming black in sporonts.	Dense	Not described	Not described.
9. Cyst	Irregularly spherical, with slight depressions and protuberances.	Irregularly spherical, surface covered with indentations and papillae.	Unknown	Unknown.
10. Spores	Brown, united in chains; 7 μ in length.	Same as in <i>S. oblongatus</i> .	Ditto	Ditto.
11. Host	<i>Opotrum sabulosum</i> (L.), & <i>Ascidia grisea</i> (F).	<i>Blaps mortisaga</i>	<i>Hydrophilus</i> sp., larva	<i>Helenophorus collaris</i> L.
12. Habitat	Intestine	Intestine	Intestine	Intestine.
13. Locality	Paris and Poitiers, France.	Paris	Germany	Grenoble, France.

Characters.	<i>S. giganteus.</i>	<i>S. insignis.</i>	<i>S. eledonae.</i>	<i>S. bahli.</i>
1. Sporonts	Solitary, elongate; maximum size 1800 μ .	Solitary, very elongate; length 1000 μ .	Solitary, maximum length 300 μ .	Solitary, elongate; maximum length 2000 μ .
2. Epimerite	A long pointed cone, situated upon a conoidal projection of the protomerite.	A large flattened disc, depressed slightly in centre crenulate on periphery, longitudinally striated and carrying at base a circle of very many short upwardly directed digitiform processes.	Long and thick style with a small knob at its extremity.	An elongated, hollow, tubular structure, consisting of two parts (i) a proximal neck which is hyaline and retractile and (ii) a distal tongue-like portion. Length on an average two-and-a-half times than that of the protomerite but it never exceeds the total length of the adult gregarine.
3. Protomerite.	Dome-shaped, dilated above the base, and flattened anteriorly; constriction at the septum.	Sub-globose, flattened, twice as wide as high; constriction at the septum.	Hood-shaped or obtuse, cone-like in appearance; stuffed with small reserve granules; constriction at the septum.	Usually broader than long, conical or sub-conical; constriction at the septum.
4. Deutomerite	Cylindrical, widest at the septum, terminating in an abrupt but sharply pointed cone.	Cylindrical, widest at end of anterior third, flattened at posterior extremity.	Widest shortly behind the septum, tapering to a fully stumpy hinder end posteriorly.	Widest at the septum, tapering gracefully posteriorly, but never ending in a sharp point.
5. L.P. : L.T.	1 : 9 to 1 : 18	1 : 15	1 : 6 to 1 : 7	1 : 18 to 1 : 63.
6. W.P. : W.D.	1 : 1 to 1 : 1.5	1 : 1.3	1 : 1.2 to 1 : 1.4	1 : 1.38.
7. Nucleus	Not described	Spherical with one karyosome.	Relatively small	Ellipsoidal often with several karyosomes.
8. Endocyte	Dense	Not described	Conspicuously big granules present.	Brown in cephalonts becoming dark-blue in sporonts.
9. Cyst .	Spherical, diam. 450 μ ; entire surface papillated; dehiscence by pseudocyst.	Sub-spherical or sub-ovoidal, diam. 430 \times 330 μ ; dehiscence by pseudocyst.	Unknown	Spherical, subspherical or egg-shaped; entire surface papillated; diam. 208 μ -352 $\mu \times$ 80 $\mu \times$ 320 μ ; dehiscence by pseudocyst or simple rupture.
10. Spores	Irregularly sub-spherical, black and measure 11 $\mu \times$ 7 μ united in chains.	Irregularly hat-shaped, 10 μ long, extruded in chains.	Unknown	Irregularly hat-shaped, dark-brown or black and measure 11 $\mu \times$ 7.5 μ ; united in chains.
11. Host	<i>Eleodes</i> sp.; <i>Asida apaca</i> Say; <i>Asida</i> sp., and <i>Eusattus</i> sp.	<i>Helops striatus</i>	(i) <i>Eledona agaricola</i> , Herbst. (ii) <i>Pentaptyllus testaceus</i> , Hellw. (iii) <i>Myceto-phagus picus</i> Fabr.	<i>Gonocephalum helopioides</i> Frm.
12. Habitat	Intestine	Intestine	Intestine	Mld. gut and intestine.
13. Locality	Boulder and Denver, Colo.	Indre-et-Loire, France	(i) Fundort : By Sibyllenort. (ii) Fundort : Millitsch. (iii) Fundort : Millitsch.	Lucknow, U. P. India.

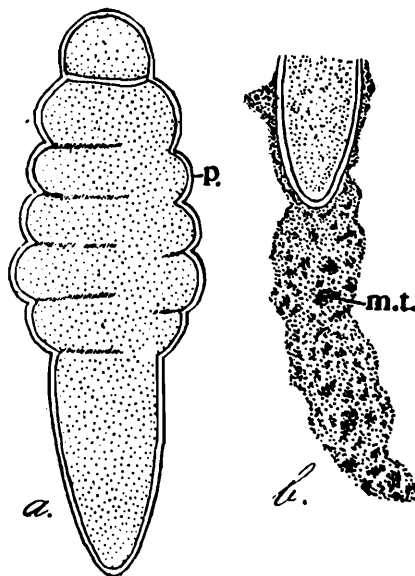
MOVEMENT.

(a) Observations on the movement of *S. bahli*, sp. nov.

When a piece of infected gut is teased on a slide and the gregarine examined under the microscope it does not move at all in the gut-fluid of the host. In distilled water slow movement can be observed, but only for a short duration. Normal saline is a suitable medium for studying the movements of gregarines, as they can live in it for a longer duration, and for this particular gregarine 0.9 per cent. saline solution proved a better fluid than the usual physiological saline solution.

The epimerite of *S. bahli* is retractile and shows active bending movements, as well as slight longitudinal contortions. When not retracted it moves to and fro and then curls up to form a coil which opens out with a jerk. More often complete bending is not effected and the epimerite moves to the right and then to the left, as if it is searching for something. The protomerite also moves to and fro but with a greater activity than the epimerite. Sometimes it was noted that it could withdraw partially into the deutomerite and then suddenly sprang out to withdraw again, and this process was repeated several times. These movements can be compared with those of the neck of a turtle which is being partially withdrawn and extruded alternately. Occasionally, the septum was pushed into the protomerite by the onward flow of the cytoplasm of the deutomerite. These movements are, however, not necessarily seen at all times.

Sometimes, neither the epimerite nor the protomerite shows any active movements and the gregarine as a whole glides along passively. Usually *S. bahli* moves forward both by movements of epi- and protomerites and by gliding movements at the same time. When it comes in contact with an obstacle it pauses a little, changes its direction and



TEXT-FIG. 15.—a. A specimen of *S. bahli* showing cap-like protuberances (*p.*): \times ca. 200.
b. An individual showing the mucus-tail (*m.t.*): \times 200.

continues forward. In its attempt to put aside obstacles in its way several cap-like projections, (2-12), are formed on the deutomerite

(text-fig. 15 *a*), these protuberances are produced as a result of the pressing of the body against the obstacle lying in front, and when the organism is unable to push that obstacle away, it recoils with a backward jerk or takes a slight turn and makes its way onwards. Probably, it is this backward jerk which certain authors have mistaken for a backward movement. I have never been able to detect in this gregarine a backward movement similar to its forward movements. I have also noted that an individual at times, while gliding, forms a slight curve on its body and then instantaneously straightens out, in which act the body, instead of moving forwards moves at right angles to its long axis; it is this lateral flexion, probably, which Crawley has named "transverse" movement¹.

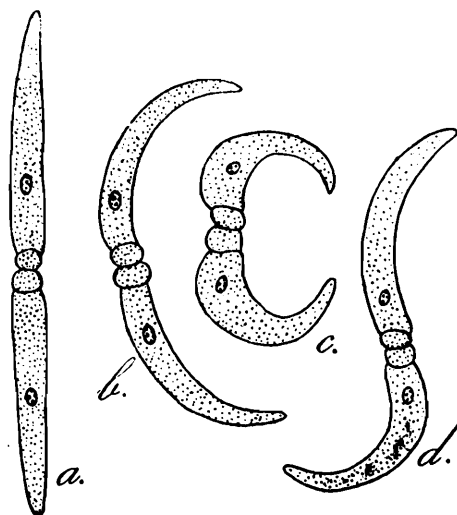
In order to test whether this gregarine could move only when in contact with a surface, half a dozen specimens were kept in saline solution under a wax-legged cover-glass and examined under high power. By changing the focus of the microscope it could be seen that they remained attached to the slide on which they moved. I was unable to see any of the gregarines leaving the slide to move upwards and reach the coverslip, as has been recorded by Crawley (*vide infra*).

Besides these facts, one important observation needs mention here. A fresh preparation in saline after five minutes showed a sticky and elastic tail being formed, presumably by the exudation of a mucoid substance from the body of the gregarine and its subsequent accumulation at the posterior end forming a "tail". To obtain a clear conception of this phenomenon about half a dozen gregarines were washed several times in saline solution, to get rid of the gut-fluid of the host and were kept in saline mixed with carmine suspension. It was observed that as the gregarines moved forward the carmine particles collected at their posterior ends and formed a "tail" (Pl. III, fig. 3, *m. t.*; text-fig. 15 *b*, *m. t.*). The "tail" may not be continuous. This suggests that there is a variation in the quantity of the exudate. It may be mentioned here that the "tail" actually retards the progress of the animal and when it becomes fairly big the organism, in spite of its best efforts to escape from it, succumbs at last. A definite trail or tract is often left behind each individual as it passes onwards.

In biassociative forms in which syzygy takes place by the union of the anterior end of the satellite with the posterior end of the primate, "tail-formation" is clearly visible at the hind end of the satellite, but a change in the direction during progression is steered by the primate; the satellite either helps the primate by moving in the same direction or just follows passively. In case the "tail" grows enormously big, cap-formation occurs in the bodies of the pair or the association snaps, in which case the primate escapes, leaving the satellite doomed to death. When the contact of the two associates takes place by their anterior ends only, forward progression comes to an end sooner or later and a rotatory movement is set up by the two individuals exerting forces in opposite directions. Their posterior ends approach closer and closer

¹ Personally, I consider that additions of such names should be avoided. For instance, "transverse" movements would be inconvenient on the part of an organism having the antero-posterior axis of its body longer than its transverse axis.

(text-fig. 16 *a, b, c*), and ultimately the pair rounds itself and becomes encysted in a common cyst. The rotatory movements may lead the



TEXT-FIG. 16.—*a*. Two sporonts of *S. bahli* in association; *b, c.*, same deflected due to opposite forces during progression; *d.*, showing an S-shaped deflection due to opposite forces not acting on the same side: $\times 55$.

two individuals in opposite directions, whereby an S-shaped figure (text-fig. 16 *d*) is formed. In such cases it was noticed that after some time their contact gave way and the organisms became free.

Albuminated saline or diluted glycerine inhibits progression with great rapidity. The action of certain acids, *e.g.*, 0.5 per cent. hydrochloric acid, nitric acid, sulphuric acid and acetic acid, as well as of certain alkalis, *e.g.*, 0.5 per cent. potassium hydroxide, sodium hydroxide, sodium carbonate, etc., proved in every case to be detrimental to progression, and caused death.

(b) Discussion.

The gregarines can move in a medium different from that of their natural environment, but the various factors bringing about their locomotion have formed a bone of contention amongst workers since the time the gregarines came to be known. Kölliker (1848) was the first to record the gliding and bending movements in gregarines, but he did not offer any explanation as to the cause of these movements. Leidy (1853) discovered the longitudinal striations of the epicyte and suggested their muscular function. Van Beneden detected the net work of transverse fibrillae—the so-called myocytes as named by Schneider (1873)—which are contractile and have been held responsible for the bending movements. Lankester (1872) reported upon the active movements of *Monocystis sipunculi* caused by the undulations of their lateral margins and suggested that they were like those of a planarian. Frenzel (1892) suggested that progression was due to a chemotactic affinity between the gregarines and their food, but this suggestion seems to be inadequate, as the gregarines do not show any movement on a slide with food materials on it. Following Lauterborn's observations on diatoms which move by the extrusion of gelatinous threads, Schewiakoff (1894) from his studies on *Clepsidrina mureri*, concluded that the same

phenomenon occurred in gregarines. According to him gelatinous threads exude through minute pores lying in between the ridges of the gregarines and accumulate at the posterior end, where they harden into a tough stalk, new additions to which push the animals forwards. Mühl (1921) demonstrated the presence of minute pores on the body by means of carbon tetrachloride. Lang and Doflein supported Schewiakoff's theory, while Calkins (1910) stated, "although very improbable at first sight, it is the only one thus far that fits the case" Schaudinn (1900) also supported Schewiakoff's observations by demonstrating the secretion of a gelatinous substance from the sporozoite of *Coccidium schubergi*. Although Schewiakoff worked out elaborately the mechanism of locomotion in gregarines for the first time, his emphasis upon the "mucus-tail" as a pushing element has led to a good deal of criticism. Crawley (1902, 1905) from his observations on *Stenophora juli* and *Echinomera hispida* concluded that myonemic contractions were entirely responsible for bringing about locomotion, and as mucus was merely dragged passively at the posterior end, tail-formation is an effect rather than a cause of locomotion. He says "It is an intrinsic weakness of Schewiakoff's explanation that it gives no reason why the gelatinous substance should pass backwards, instead of forwards or radially" In support of his view he has asserted that throughout the whole group of Sporozoa movement is exhibited only by those organisms which possess a muscular system. For instance, a gregarine even in its intra-cellular stage would exhibit movement, if detached from its moorings, but an adult coccidium is unable to move, as it possesses no muscular system. Further, movement is exhibited by Haemosporidia and Myxosporidia on account of the presence of a muscular system, whereas Amoebosporidia (Schizogregarines) are devoid of muscles, and are, therefore, non-motile. Thus according to Crawley, it seems strange why nature could have developed in the Polycystid gregarines a unique method of progression (as described by Schewiakoff) caused by the exudation of mucus when the muscular system is already present. Watson (1916) has also opposed Schewiakoff's theory and holds that the tail inhibits rather than promotes progression. In *S. bahli* also, it was clearly noted that with the increasing length and weight of the mucus-tail the speed of movement became slower and slower. If Schewiakoff's view is accepted, it is not understandable as to how the organisms would move when not even a trace of tail is noticed. It is, however, equally inexplicable, in actual observation, as to how the animal is able to drag forwards and cover a distance several times the total length of the tail formed by that time. It appears cogent that the mucus tail is not an aid but a definite impediment in the course of progression and is formed as an effect of locomotion rather than its cause.

According to Awerinzew (1910) both Schewiakoff's and Crawley's theories are objectionable.

Porter (1897), working on *Rhyncobolus americanus*, concluded, "It (locomotion) is probably caused by a very slight undulatory motion of the under surface of the animal" Lühe (1904), Paehler (1904), Schellack (1907), Voss (1922), Berlin (1924), Cognetti De Martiis (1927),

and others have supported Porter's theory. Roskin and Levinson (1929) could not observe slime exudation in *Nematocystis* sp. and *Polycystis* sp., and held that the contractions of the circular and longitudinal myonemes bring about locomotion in the same way as an earthworm moves through contractions of its longitudinal and circular musculature. Bowling has observed the thickening of the remarkable threads of *Zygocystis zonata*, both in the living and fixed material, but whether this indicates a cause or a result of movement is not clear. Sokolow (1912) believes, on the principle of a skyrocket, that locomotion is caused by the forceful expulsion of the fluid and contradicts Crawley's explanation of myonemic contractions. Watson (1916), from her studies on *Leidyana erratica*, has made a compromise between the two rival theories of Crawley and Sokolow by suggesting that the locomotion is caused by the myonemic contractions of that side of the animal which happens to be ventral at that time, mucus exudation merely creating friction as in the locomotion of *Limax*. Ray (1933) has confirmed Watson's explanation, excepting that he could not detect the continuity of the mucus-tail in *Stenophora khagendrae*. I agree with Watson's explanation but only for those gregarines which have developed a muscular system and not for forms like *Cephaloidophora communis* and *Chlamydocystis captiva*, which also move but possess a very feebly developed myonemic layer. In such cases undoubtedly, it is the forceful expulsion of the jelly-like substance which would take the leading part. In conclusion, it may be added that the phenomenon of movement cannot be attributed to a single cause: the type of movement, its speed and moving capacity are dependent upon the inter-action of several factors between the organism and its environment.

As regards the movements of gregarines within the body of the host certain authors have expressed the opinion that they do not move, as is evidenced by their dormant condition when an infected gut is teased and examined fresh. My observations also confirm the fact that they remain inactive in the gut-fluid even outside the body, but it is difficult to understand as to why there should have been a mechanism for locomotion at all. The probable cause of their inactivity in the exposed gut-fluid is due to the fluid becoming instantaneously viscid in the air, inhibiting the movements of the gregarines contained therein. It is probable, that the gregarines do move after detachment from the parasitised cells inside the body of the host in order to avail themselves of a greater range of nutrient material, and also to save themselves from being swept along with the food currents before encystment and that the bending movements of parasites chiefly help them in the formation of cysts.

Whether gregarines creep or swim different authors have expressed different opinions. For example, Crawley says, "Gregarines either lie against the under surface of the coverslip or upon the slide, which can be shown by raising or lowering the tube of the microscope. This shows that all studies on progression have been made on animals which are in contact with a surface." He has shown that a gregarine may be seen leaving the slide and coming upwards towards the coverslip: movement in this case having been effected by a contact of surface

(to creep upon) as offered by the extraneous particles present in the fluid. Mühl (1921) mentions that gregarines can crawl as well swim, depending upon the medium in which they are kept. I agree with Crawley's interpretation and it appears to me that in those gregarines in which the myonemes are well developed and mucus also exudes, creeping would be easier than swimming.

SUMMARY.

- (1) A new record of the genus *Stylocephalus* (*Stylorhynchus*) from India has been made, and an account of the life-history of *S. bahli*, sp. nov., found in *Gonocephalum helopioides* Frm. has been given in detail.
- (2) This gregarine passes all its developmental stages outside the epithelial cells of the host, as no intra-cellular stage was encountered.
- (3) Sporonts are solitary and associate by their anterior ends. Gametes are anisogamous. Spores are hat-shaped and are arranged in chains, each containing eight spindle-shaped or fusiform sporozoites.
- (4) Dehiscence is either by pseudocyst or by a simple rupture.
- (5) Infection is purely accidental, and there is evidence of seasonal intensity of infection.
- (6) The phenomenon of polynuclearism—a rare occurrence in gregarines—has been observed in *S. bahli*.
- (7) This gregarine seems to be susceptible to attacks of certain fungi belonging to the family Chytridiaceae which hyperparasitize its cytoplasm as well as its nucleus.
- (8) The mechanism of movement in gregarines has been discussed and an account of the observations made upon the movement of *S. bahli* has been included.
- (9) A comparison of the various species of *Stylocephalus* has been given in a tabulated form.

ACKNOWLEDGMENTS.

This work has been conducted under the direct guidance of Prof. K. N. Bahl to whom I wish to submit my most respectful thanks for his encouragement, helpful suggestions and correction of this manuscript. My thanks are also due to Dr. H. N. Ray, Systematic Protozoologist, Imperial Veterinary Research Institute, Mukteswar-Kumaun, U. P., for critically examining my slides, confirming my observations, and reading through the manuscript. Dr. M. L. Bhatia has very kindly helped me in improving some of the sketches for which I am obliged to him.

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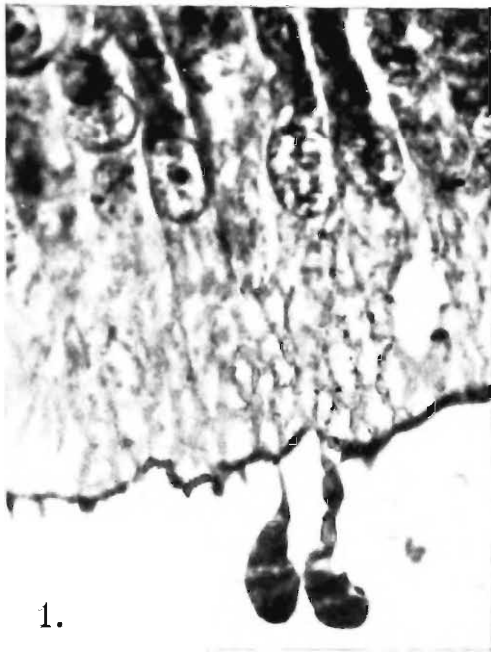
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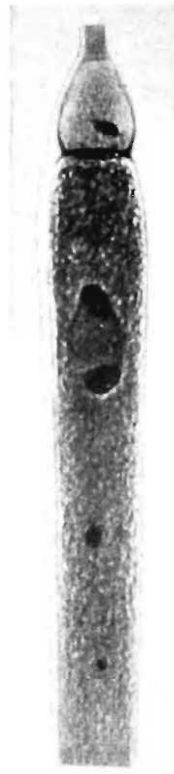
EXPLANATION OF PLATE III.

Stylocephalus bahli, sp. nov.

- FIG. 1.—Two young trophozoites attached to the epithelial cells of the host and showing faint indications of compartments on their bodies : $\times 1133$.
- FIG. 2.—A chain of macrogametes ; \times shows the entrance of a microgamete into the receptive spot of the macrogamete : $\times 625$.
- FIG. 3.—A sporont showing nuclear degeneration due to hyperparasitism : $\times 1200$.
m.t., mucus-tail.
- FIGS. 4, 5.—Sporonts showing polynuclearism : $\times 500$.
- FIG. 6.—An oblique section of the parasite showing the multi-nucleate amoeboid bodies (*see text-fig. 13 a*) : $\times 900$.
- FIG. 7.—A portion of the gametocyst showing the completion of nuclear division in the male gametocyte (*m.*), whereas in the female (*f*) it is still in progress : $\times 350$.
- FIG. 8.—A transverse section of the gut of the host showing occlusion due to abundance of parasites therein : $\times 260$.



1.



4.

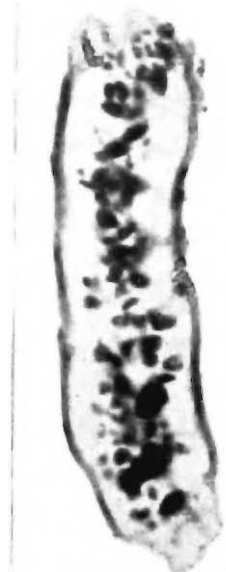


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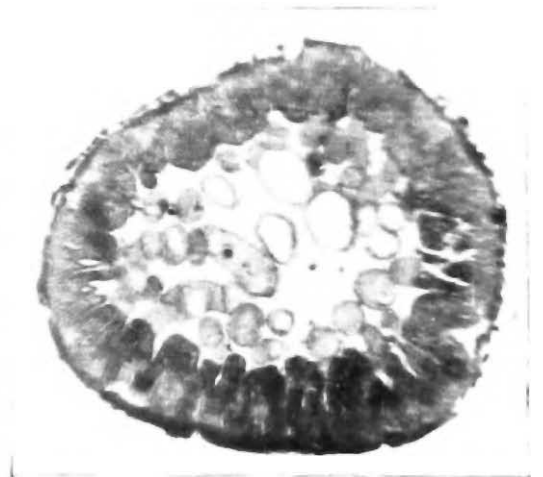


m.t.

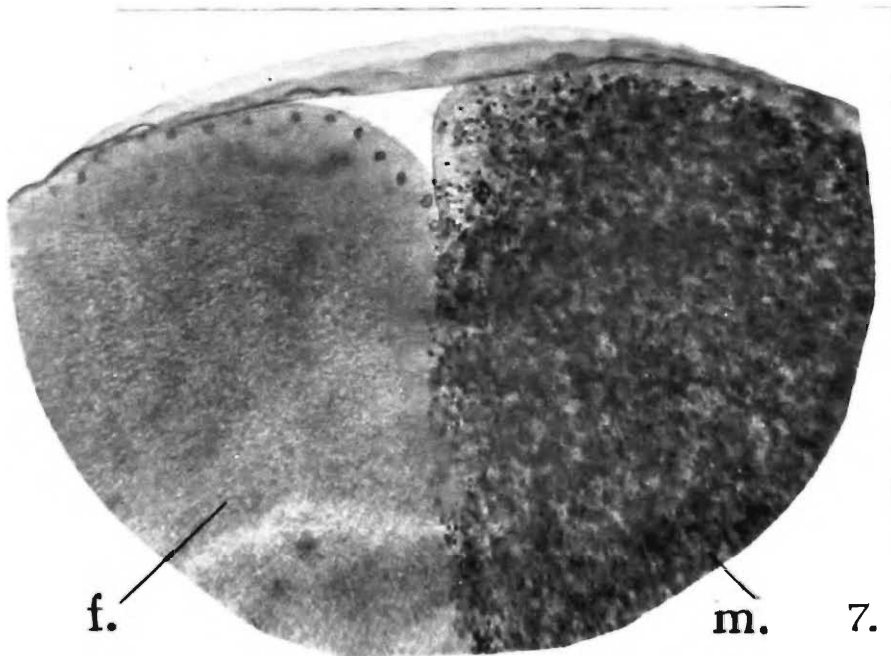
3.



6.



8.



f.

m.

7.



5.

Stylocephalus bahli, sp. nov.

NOTES ON INDIAN HEMIPTERA IN THE ZOOLOGICAL SURVEY OF INDIA.

I. ON THE SUBFAMILY PLATASPINAE OF THE FAMILY PENTATOMIDAE.

By H. A. HAFIZ, Ph.D. (London), D.I.C. (London), Assistant Superintendent, and S. RIBEIRO, Entomological Assistant, Zoological Survey of India.

INTRODUCTION.

In this series of notes we propose to publish from time to time the results of our work on the unnamed material of Hemiptera in the collections of the Zoological Survey of India. In general we follow the monographic work of Distant on the Rhynchota, which was published in the "Fauna of British India" series between the years 1902 and 1918, as this still constitutes the only comprehensive work on the Indian Hemiptera, but more recent work on the subject has also been consulted.

This paper deals with the genera *Cratoplatys* Montandon, *Tarichea* Stål, *Oncylaspis* Stål, *Brachyplatys* Boisduval and *Coptosoma* Laporte, comprising twenty-four species. In all, we have determined three hundred and seventy-seven, mostly pinned specimens.

With reference to the position of the genus *Carrabas* Distant it may be noted that Distant¹ placed it after the subfamily Plataspinae but commented upon its close approach to the genus *Thyreocoris*. McAtee and Malloch² remarked on its resemblance to the subfamily Thyreocorinae, but owing to the paucity of material were not able to define its exact relationships.

In conclusion, we take this opportunity to express our sincere thanks to Dr. Baini Prashad, Director, Zoological Survey of India, for his kindness in going through the manuscript of the paper.

SYSTEMATIC ACCOUNT.

Family PENTATOMIDAE.

Subfamily PLATASPINAE Distant.

- 1851. *Plataspidae*, Dallas, *List Hem.* I, p. 61.
- 1902. *Plataspidinae*,³ Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 3, 4.
- 1903. *Plataspinae*, Distant, *Fasc. Malay.* II, p. 223.
- 1908. *Coptosomatinae*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 132.
- 1908. *Plataspidinae*, Distant, *Faun. Brit. Ind., Rhyn.* IV, p. 421.
- 1909. *Coptosominae*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, pp. 316, 317.
- 1912. *Plataspidae*, Oshanin, *Kat. paläarkt. Hem.*, p. 3.
- 1916. *Plataspidae*, Oshanin, *Horae Soc. Ent. Ross.* XLII, p. 21.
- 1918. *Plataspidinae*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 110.

¹ Distant, W. L., *Faun. Brit. Ind., Rhyn.* IV, pp. 421, 422, fig. 256 (1908).

² McAtee, W. L. and Malloch, J. R., *Ann. Carnegie Mus.* XXI, pp. 196, 199, 393 and 395, figs. 75 and 258-260 (1933).

³ Referred to by Distant in his synonymy as *Plastipidae* Dallas. This is apparently a printer's error for *Plataspidae* cf. Dallas, W. S., *List Hem.* I, p. 61 (1851).

1925. *Plataspidae*, Pruthi, *Trans. Entomol. Soc.*, pp. 142, 143 and 149-151.
 1926. *Plataspidae*, Esaki, *Ann. Hist.-nat. Mus. Nat. Hungar.* XXIV, p. 142.
 1927. *Coptosomidae*, Bergroth, *Ark. Zool.* XVIII (A), p. 1.
 1928. *Plataspidae*, China, *Journ. Fed. Malay States Mus.* VIII, p. 185.

Plataspinae has been more frequently referred to by Rhynchotists as a distinct family. Pruthi (*loc. cit.*, pp. 143, 150) in his work on the morphology of the male genitalia in Rhynchota, however, restored it to its proper place as one of the subfamilies of Pentatomidae. According to Pruthi, Plataspinae should be placed near the subfamilies Pentatominae and Scutellerinae. Distant (1902, p. 2), in his synoptical key of the subfamilies of Pentatomidae, separated Plataspinae by the nature of its hemelytra, which are "longer than the body, (and) folded in at the base of (the) membrane" We follow Distant's arrangement.

Dallas (*loc. cit.*, p. 61) considered this group of Hemiptera as constituting a distinct family. He called it *Plataspidae*. Distant (1902, p. 3) regarded it as a subfamily of Pentatomidae and named it *Plataspidinae*. In a subsequent paper, Distant (1903, p. 223) changed the name to *Plataspinae* but later (1908, p. 421 and 1918, p. 110) he again used *Plataspidinae*. The name *Plataspinae*, as employed by Distant (1903, p. 223), is more in accordance with the International Rules of Zoological Nomenclature¹ and has, therefore, been adopted here.

Genus *Cratoplatys* Montandon.

1894. *Cratoplatys*, Montandon, *Ann. Mus. Civ. Stor. Nat. Genova* (2) XIV, pp. 119, 120.
 1902. *Cratoplatys*, Distant, *Faun. Brit. Ind.*, *Rhyn.* I, p. 5.
 1908. *Cratoplatys*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 132.
 1909. *Cratoplatys*, Kirkaldy, *Cat. Hem. (Het.)*, *Cimicid.* I, p. 318.

Montandon (*loc. cit.*, p. 119) described the genus *Cratoplatys* and considered it to be allied to the genera *Heterocrates*, *Handhirschiella* and *Aphanopneuma*. The single male specimen of *Cratoplatys gestroi* Montandon, described elsewhere, appears to be related also to the genus *Ceratocoris* on account of the corniform appendages of the head, the position of the ocelli and the appearance of the margins of the abdomen as seen from below. *Ceratocoris*, however, differs from *Cratoplatys* in the shape of the head and the form of the corniform appendages, the situation of the true spiracles present in the abdomen and in the short and compressed tibiae of the legs, which are scarcely longer than the tarsi. It may be added that the genus *Cratoplatys* is also related to the genus *Aphanopneuma* due to the hidden position of the spiracles, which is equally characteristic of *Cratoplatys gestroi* Montandon, the slender tibiae of the legs and the smaller tarsi.

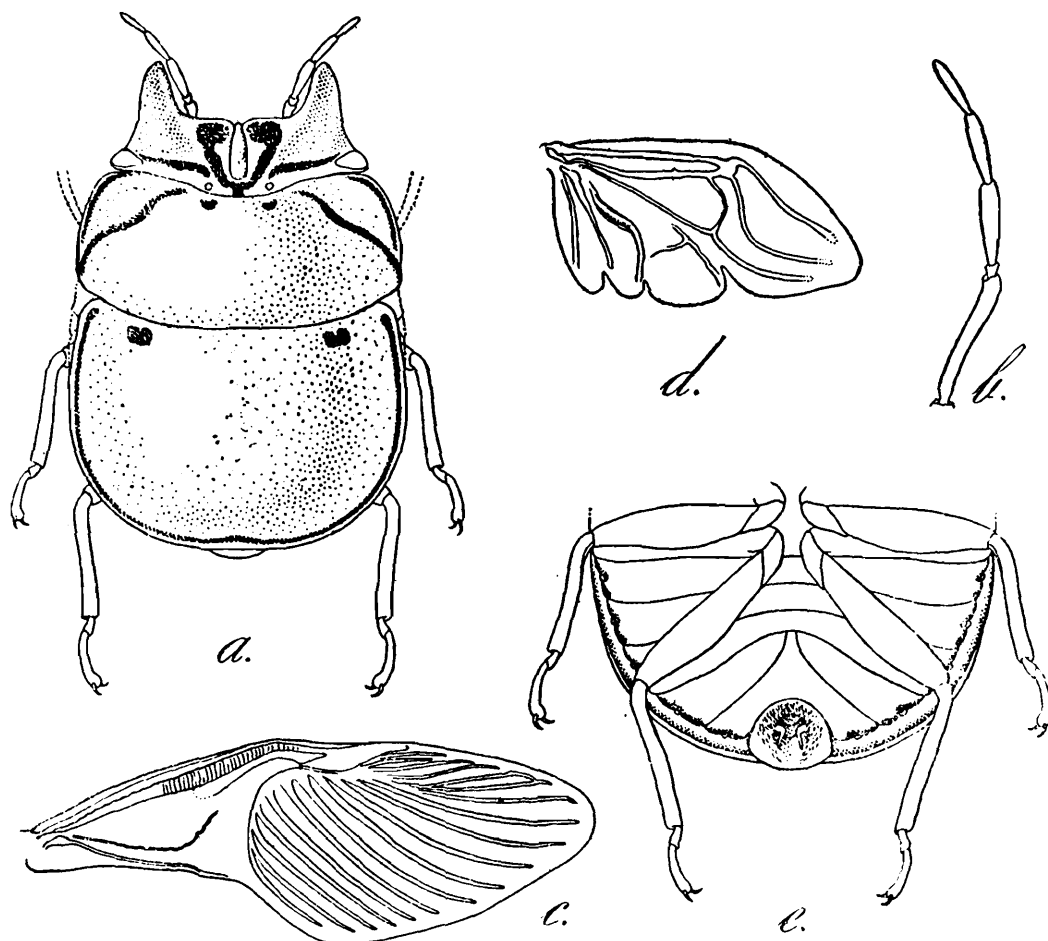
Cratoplatys gestroi Montandon.

1902. *Cratoplatys gestroi*, Distant, *Faun. Brit. Ind.*, *Rhyn.* I, pp. 5, 6, fig. 2.
 1908. *Cratoplatys gestroi*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 132.
 1909. *Cratoplatys gestroi*, Kirkaldy, *Cat. Hem. (Het.)*, *Cimicid.* I, p. 318.

We refer to this species a single male pinned example, which we describe and figure here. Only the female has hitherto been known.

¹ Schenk, E. T. and McMasters, J. H., *Procedure in Taxonomy*, p. 27, article 4 (1936).

♂ (*pinned*).—Like the female except in the following details. The head bears two pointed horn-like processes, which are situated at



Cratoplatys gestroi Montandon. ♂.

a. Dorsal view: $\times 3\frac{1}{4}$; b. Right antenna: $\times 7$; c. Right hemelytron: $\times 4\frac{1}{4}$; d. Right wing: $\times 4\frac{1}{4}$; e. Ventral view of abdomen: $\times 4$.

the anterior outer areas of the lateral lobes. The central lobe is free and is as long as the lateral lobes, which are broad and foliaceous. The inner areas of the lateral lobes are each furnished with a comma-shaped ochraceous marking. These markings unite together at the basal margin of the head at a point, medially, between the ocelli. The apical margin of the scutellum is incised in the middle. The segments of the abdomen on the ventral surface have an impressed line on each side ending near the margin of the abdomen and there is a series of sinuate ochraceous markings at the apices of the abdominal segments.

Length.—12.3 mm. *Max. breadth*.—9.6 mm.

♂ *specimen*.—No. 5931/H7, Zoological Survey of India (*Ind. Mus.*).

Locality.—Foot hills, Pegu Yomas, Thayetmyo district, Lower Burma (C. J. Rogers, x.1911).

The holotype female of this species, from Palon, Pegu, Burma (L. Fea), is probably in the Genoa Museum.

The species had hitherto not been represented in the collection of the Zoological Survey of India.

Genus **Tarichea** Stål.

1902. *Tarichea*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 6.

1909. *Tarichea*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 322.

So far only two species of this genus viz. *T chinensis* (Dallas), male and female, from China (Brit. Mus.) and *T nitens* (Dallas), female, from North India (Brit. Mus.) and North-West Himalayas (Distant Coll.) are known.

Tarichea nitens (Dallas).

1902. *Tarichea nitens*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 6, 7, fig. 3.

1909. *Tarichea nitens*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 322.

We assign to this species twenty-three male and thirty-four female pinned specimens, all from Dehra Dun, United Provinces.

The apical margin of the scutellum in the male of *T nitens* is emarginate. Moreover, the dorsal apical margin of the ninth abdominal segment is ciliate; the segment itself being more or less clothed throughout with short brownish-ochraceous pubescence.

Genus **Oncylaspis** Stål.

1851. *Plataspis*, Dallas, *List Hem.* I, pp. 72-74 (*Partim*).

1864. *Oncylaspis*, Stål¹, *Hem. Afr.* I, p. 2.

1866. *Oncylaspis*, Stål, *Berliner Ent. Zeitsch.* X, p. 151.

1876. *Oncylaspis*, Stål², *Enumer. Hem.* V, pp. 4 and 6.

1887. *Oncylaspis*, Atkinson, *Journ. Asiat. Soc. Bengal* LVI, pp. 24, 25.

1902. *Oncylaspis*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 7.

1909. *Oncylaspis*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 322.

Dallas (*loc. cit.*, pp. 73, 74) described a male and a female from Tenasserim as *Plataspis ruficeps*. Stål (1864, p. 2) later recognized this species as constituting a separate genus, which he called *Oncylaspis*.

Oncylaspis ruficeps (Dallas).

1851. *Plataspis ruficeps*, Dallas, *List Hem.* I, pp. 73, 74.

1864. *Oncylaspis ruficeps*, Stål, *Hem. Afr.* I, p. 2.

1866. *Oncylaspis ruficeps*, Stål, *Berliner Ent. Zeitsch.* X, p. 151.

1876. *Oncylaspis ruficeps*, Stål, *Enumer. Hem.* V, p. 6.

1887. *Oncylaspis ruficeps*, Atkinson, *Journ. Asiat. Soc. Bengal* LVI, p. 25.

1902. *Oncylaspis ruficeps*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 7, fig. 4.

1909. *Oncylaspis ruficeps*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 322.

We refer to this species two female pinned specimens from LeO, 1,170 feet, Upper Burma (Miss Molesworth, x.1915).

O. ruficeps (Dallas) was originally recorded from Tenasserim (Brit. Mus.) and later from Burma (Holm. Mus.), Karen Hills (Doherty) and Cochin China.

The species was hitherto not represented in the collections of the Zoological Survey of India.

¹ This work is unfortunately not available in Calcutta.

² The *Enumeratio Hemipterorum* was originally published in *Kongl. Svensk. Vetensk.-Akad.* between the years 1870 and 1876. The reference cited above appeared in volume XIV, No. 4, pp. 4 and 6 of this publication for the year 1876.

Genus **Brachyplatys** Boisduval.

1902. *Brachyplatys*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 8.
 1908. *Brachyplatys*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 133.
 1909. *Brachyplatys*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 323.
 1918. *Brachyplatys*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 110.

The Indian species of the genus *Brachyplatys* need revision. In this connection, reference may be made to *B. pauper* Vollenhoven and *B. radians* Vollenhoven, both of which are generally treated as varieties of *B. subaëneus* (Westwood) and *B. vahlii* (Fabricius) respectively.¹

Brachyplatys subaëneus (Westwood).

1902. *Brachyplatys subaeneus*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 11.
 1909. *Brachyplatys subaeneus*, Lefroy, *Rec. Ind. Mus.* III, p. 302.
 1909. *Brachyplatys subaeneus*, Breddin, *Ann. Soc. Ent. Belgique* LIII, p. 250.
 1909. *Brachyplatys subaeneus*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, pp. 325 and 379.
 1910. *Brachyplatys subaeneus*, Kershaw, *Ann. Soc. Ent. Belgique* LIV, pp. 69-71, figs. 1-7.
 1926. *Brachyplatys subaeneus*, Esaki, *Ann. Hist.-nat. Mus. Nat. Hungar.* XXIV, p. 143.
 1932. *Brachyplatys subaeneus*, Hoffmann, *Arch. Zool. Torino* XVI, p. 1014.

We refer to this species three female pinned examples from the following localities :—Maini Mukh, Chittagong Hill Tracts, Bengal (R. P. Mullins, 1922); Balugaon, Puri district, Orissa (N. Annandale, 21-30.vii.1913); Mahanandi, 800 feet, foot of Nallamalai Hills, West, South India (H. S. Pruthi, 12.viii.1929).

Altogether we have examined six male and nineteen female specimens. Of the male specimens four examples are from Calcutta and the remainder are from the Andaman Islands. In all these male examples the short and conical ray-like fasciae of the abdominal segments are replaced by narrow irregular ochraceous markings.

B. subaëneus is very widely distributed, being known from India, Burma, Ceylon, China, Cochin China, French Indo-China, Siam, Malay Archipelago, Dutch East Indies, Straits Settlements, Formosa and the Philippines.

It is represented in the collections of the Zoological Survey of India from Mangpu, Darjeeling district, Eastern Himalayas; Calcutta and Maldah, Bengal; Katihar, Purnea district, Bihar; Ceylon; Andaman Islands.

Brachyplatys punctipes Montandon.

1902. *Brachyplatys punctipes*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 11.
 1908. *Brachyplatys punctipes*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 133.
 1909. *Brachyplatys punctipes*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 325.

We refer to this species two male and two female pinned examples from Tope, foot of Palni Hills, South India (S. W. Kemp, 1922).

The species has been recorded from Trichinopoly, Madras Presidency; Karennee, Burma; China; Java.

It is represented in the collections of the Zoological Survey of India by a single female pinned specimen from Rungpo, 1,400 feet, Darjeeling district, Eastern Himalayas, determined by the late Mr. C. A. Paiva.

¹ China, W. E., *Journ. Fed. Malay States Mus.* VIII, p. 185 (1928); also see Kirkaldy, G. W., *Cat. Hem. (Het.), Cimicid.* I, pp. 325, 326 (1909).

Genus **Coptosoma** Laporte.

1902. *Coptosoma*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 17.
 1908. *Coptosoma*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 134.
 1908. *Coptosoma*, Distant, *Faun. Brit. Ind., Rhyn.* IV, p. 421.
 1909. *Coptosoma*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 327.
 1912. *Coptosoma*, Oshanin, *Kat. paläarkt. Hem.*, p. 3.
 1916. *Coptosoma*, Oshanin, *Horae Soc. Ent. Ross.* XLII, p. 21.
 1918. *Coptosoma*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 111.

Since the publication of Distant's volumes in the "Fauna" series, three other species of *Coptosoma* from India and Ceylon have been described. These are *C. galathea* Jensen-Haarup,¹ *C. montandoni* Bergroth² and *C. sikkimensis* China³ and are not represented in the collections of the Zoological Survey of India.

Coptosoma duodecimpunctatum (Germar).

1902. *Coptosoma duodecimpunctatum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 19.
 1903. *Coptosoma duodecimpunctatum*, Distant, *Fasc. Malay.* II, p. 224.
 1909. *Coptosoma duodecimpunctatum*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, pp. 331 and 379, 380.
 1909. *Coptosoma 12-punctatum*, Breddin, *Ann. Soc. Ent. Belgique* LIII, p. 250.

We assign to this species three male and eight female pinned examples from the following localities:—Mangpu to Rieng, 1,500-3,500 feet, Darjeeling district, Eastern Himalayas (S. W. Kemp, 10.v.1917); Dejoo, North Lakhimpur district, base of hills, Upper Assam (H. Stevens, 1910); Barkul 0-1,000 feet, Puri district, Orissa (F. H. Gravely, 1-3.viii.1914); Tope, foot of Palni Hills, South India (S. W. Kemp, 1922); Mormugao, Portuguese India (S. W. Kemp, ix.1916).

C. duodecimpunctatum is recorded from Sikkim; Khasi Hills and Cachar, Assam; Palon, Pegu, Burma; Nalanda, Ceylon; Malay Peninsula (throughout).

The species is represented in the collections of the Zoological Survey of India from Kurseong, 6,000 feet, Darjeeling district, Eastern Himalayas; Sikkim; Samgooting, Assam; Bangalore, 3,000 feet, South India.

The specimen from Bangalore is entirely black, neither spotted nor marked on the pronotum, without any markings at the lateral margins of the abdomen and with the legs piceous in colour.

Distant (1903, p. 224) and Kirkaldy (*loc. cit.*, p. 380) recorded *Acacia* as its host-plant.

Coptosoma contectum Montandon.

1902. *Coptosoma contectum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 21.
 1908. *Coptosoma contecta*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 135.
 1909. *Coptosoma contecta*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 331.
 1918. *Coptosoma contectum*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 111.

We refer to this species nine pinned specimens, five males and four females, from Soom, 4,000-5,000 feet (F. H. Gravely, 14.vi.1914), Pashok,

¹ Jensen-Haarup, A. C., *Ent. Medd.* XVI, p. 44 (1926). This publication is not available in Calcutta.

² Bergroth, E., *Ann. Soc. Ent. Belgique* LVIII, pp. 183, 184 (1914). It may be remarked here that Distant later noticed *C. montandoni* by name only but did not refer to it in detail. Cf. Distant (1918, p. 151).

³ China, W. E., *Ann. Mag. Nat. Hist.* (10) VII, pp. 576-578, fig. 2 (1931).

4,500-5,500 feet (F. H. Gravely, 26.v-14.vi.1914) and Mangpu (S. W. Kemp), Darjeeling district, Eastern Himalayas.

The species is already known from Rungbong Valley and Lebong, Darjeeling district, Eastern Himalayas.

It is represented in the collections of the Zoological Survey of India from Lebong, 6,000-6,600 feet, Darjeeling district, Eastern Himalayas.

***Coptosoma ramosa* Walker.**

1867. *Coptosoma ramosa*, Walker, *Cat. Het.* I, p. 93.

1902. *Coptosoma ramosum*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 21, 22.

1909. *Coptosoma ramosa*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 337.

There are two pinned specimens, a male and a female, of this species from Trincomalee, Ceylon, in the collections of the Zoological Survey of India. The specimens were determined by Dr. F. H. Gravely.

The species is also known to occur in the Andaman Islands ; Papua ; New Guinea ; Birara.

***Coptosoma cribrarium* (Fabricius).**

1798. *Cimex cribrarius*, Fabricius, *Ent. Syst. Suppl.*, p. 531.

1902. *Coptosoma cribrarium*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 22, 23, fig. 11.

1903. *Coptosoma cribrarium*, Distant, *Fasc. Malay.* II, p. 224.

1909. *Coptosoma cribraria*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, pp. 331 and 379, 380.

1909. *Coptosoma cribrarium*, Lefroy, *Rec. Ind. Mus.* III, p. 302.

1910. *Coptosoma cribrarium*, Kershaw, *Ann. Soc. Ent. Belgique* LIV, pp. 71, 72, figs. 8-11.

1912. *Coptosoma cribrarium*, Oshanin, *Kat. paläarkt. Hem.*, p. 3.

1913. *Coptosoma cribraria*, Aiyar, *Journ. Bombay Nat. Hist. Soc.* XXII, pp. 412, 413, pl. B (pt.).

1915. *Coptosoma cribraria*, Gravely, *Rec. Ind. Mus.* XI, p. 510.

1926. *Coptosoma cribrarium*, Esaki, *Ann. Hist.-nat. Mus. Nat. Hungar.* XXIV, p. 142.

We refer to this species fifty pinned specimens, comprising twenty-seven males and twenty-three females, with two nymphs in spirit, from the following localities :—one female from Chashma Shahi, Srinagar, Kashmir (B. Chand, 5.ix.1928) ; two females from Pashok, 2,500 feet, Darjeeling district, Eastern Himalayas (F. H. Gravely, 26.v-14.vi.1916) ; one female from Maini Mukh, Chittagong Hill Tracts (R. P. Mullins, 1922), one female from Khargpur (R. A. Hodgart, 17-30.vi.1911) and one male, one female, and two nymphs from Calcutta (C. Paiva, 18.viii.1916 ; F. H. Gravely 16.iii.1911 “ on *Pongamia glabra* ”), Bengal ; two males from Pusa, Bihar (H. S. Pruthi, 26-30.viii.1925) ; one female from Barkuda Island, Chilka Lake, Ganjam district, Orissa (N. Annandale, 3.ix.1923 “ on trunk of *Pongamia glabra* attended by *Camponotus mitis* ”) ; one female from forests between Diguvametta and railway tunnel, eight miles from railway station, 1,000-1,500 feet, foot of Nallamalai Hills, East, (H. S. Pruthi, 22.viii.1929) and twenty-four males and fifteen females from Denkanikota, 3,000 feet, Salem district (H. S. Pruthi, 8-14.vii.1929), South India.

The species has been recorded from Jullundur, Punjab ; Calcutta, Bengal ; Barway, Muzaffarpur, Pusa and Ranchi, Bihar ; Naga Hills, Assam ; Nilgiri Hills and Bangalore, South India ; Bombay, Burhanpur, Jalalpur, Mahim, Nadiad and Surat, Bombay Presidency ; Bhamo,

Metanja and Swegu, Burma ; Tennasserim ; Ceylon. It is also widely distributed in Southern Asia, being known from China, Cochin China, Indo-China, Siam, Malay States, Java, Sumatra, Sunda, Timor, Formosa and Japan.

It is represented in the collections of the Zoological Survey of India by ninety-one examples, comprising forty males, forty-nine females and two nymphs from the following localities :—Rungpo, 1,400 feet and Singla, 1,500 feet, Darjeeling district, Eastern Himalayas ; Rangamati, Chittagong Hill Tracts and Calcutta, Bengal ; North-East Assam ; Bangalore, South India ; Medha, Satara district, Bombay Presidency ; Maymyo, Burma.

Kershaw (*loc. cit.*, p. 71) and Aiyar (*loc. cit.*, p. 412) have described and figured the life-history of *C. cribrarium*. The two nymphs already present in the collections of the Zoological Survey of India are rotundate in appearance and not elongate as figured by Kershaw.

Kershaw (*loc. cit.*, p. 71) has recorded the species in association with *Brachyplatys subaëneus* (Westwood) on *Pueraria thunbergiana* Benth. Aiyar (*loc. cit.*, p. 412) has reported it as one of the commonest pests of *Dolichos lablab*, also attacking agathi, red gram, indigo and cluster bean plants.

Coptosoma pravum Montandon.

1902. *Coptosoma pravum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 24.

1908. *Coptosoma prava*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 137.

1909. *Coptosoma prava*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 336.

We assign to this species a single female pinned example from Hopin, Myitkyina district, Upper Burma (B. N. Chopra, 12-13.x.1926).

The species had been known only from Myitta, Tenasserim.

It was hitherto not represented in the collections of the Zoological Survey of India.

Coptosoma sphaerula (Germar).

1902. *Coptosoma sphaerula*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 26.

1909. *Coptosoma sphaerula*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 339.

There is a single pinned female of *C. sphaerula* from Java in the collections of the Zoological Survey of India.

The species has also been recorded from Barway, Bihar ; Java ; Australia.

Coptosoma parvulum Dallas.

1902. *Coptosoma parvulum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 26.

1909. *Coptosoma parvula*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 336.

This species is represented in the collections of the Zoological Survey of India by a single male pinned specimen from Sikkim. The specimen is in a rather poor condition. Its previous record was merely East Indies.

Coptosoma assamensis Atkinson.

1886. *Coptosoma assamensis*, Atkinson, *Proc. Asiat. Soc. Bengal*, pp. 174, 175.

1902. *Coptosoma assamense*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 27.

1909. *Coptosoma assamensis*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 328.

The species is represented in the collections of the Zoological Survey of India by a single female pinned example from North-East Assam (H. H. Godwin-Austen).

Coptosoma pulchellum Montandon.

1902. *Coptosoma pulchellum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 28.
 1903. *Coptosoma pulchellum*, Distant, *Fasc. Malay.* II, p. 224.
 1908. *Coptosoma pulchella*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 137.
 1909. *Coptosoma pulchella*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 337.
 1918. *Coptosoma pulchellum*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 111.

We refer to this species two pinned specimens, a male and a female, from Neutral Saddle, 5,000 feet, Palni Hills, South India (S. W. Kemp, 13-15.ix.1922).

C. pulchellum is already known from Kodaikanal, Pondicherry and the Nilgiri Hills, South India ; Karennee, Burma ; Myitta, Tenasserim ; Malay States ; China ; Java.

The species was hitherto not represented in the collections of the Zoological Survey of India.

Coptosoma W Montandon.

1902. *Coptosoma W*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 28, 29, fig. 12.
 1908. *Coptosoma W*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 138.
 1909. *Coptosoma W*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 341.

There are in the collections of the Zoological Survey of India four female pinned specimens of this species and its varieties, presumably named by the late Mr. C. A. Paiva, as follows :—

No. 9625/15 *Coptosoma W*, from Paresnath, Bihar (N. Annandale, 9.iv.1909) ; No. 220/15 *Coptosoma W* var. *a* Distant, from Sukna, 533 feet, Eastern Himalayas ; No. 9626/15 *Coptosoma W* var. *b* Distant, from Paresnath, Bihar (N. Annandale, 9.iv.1909) ; No. 6145/15 *Coptosoma W* var., from Sukna, 500 feet, Eastern Himalayas (N. Annandale, 2.vii.1908). The last two specimens *viz.* Nos. 9626/15 and 6145/15 belong to *Coptosoma W* Montandon var. *a* Distant.

Coptosoma W has been recorded from Barway, Bihar ; Bhamo, Burma.

Coptosoma nepalensis Westwood.

1837. *Coptosoma nepalensis*, Westwood, in *Hope Cat. Hem.* I, p. 17.
 1902. *Coptosoma nepalense*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 30.
 1909. *Coptosoma nepalensis*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, pp. 335 and 382.

We refer to this species two female pinned examples, No. 9363/7 from Sikkim (E. T. Atkinson) and No. 8836/16 from Kurseong, 4,700-5,000 feet, Darjeeling district, Eastern Himalayas (N. Annandale, 23.vi.1910), determined previously as *Coptosoma fimbriatum* Distant.

The collections of the Zoological Survey of India comprise three male and two female specimens of this species from the following localities :—Pussumbing, 4,700 feet, Pashok, 2,000 and 3,500 feet and Soom, 4,000-5,000 feet, Darjeeling district, Eastern Himalayas.

C. nepalensis was originally recorded from Nepal. Since then it has been known from India and Sikkim.¹ Kuhlitz² listed it also from these localities, but Distant (*loc. cit.*, p. 30) and Kirkaldy (*loc. cit.*, pp. 335

¹ Atkinson, E. T., *Journ. Asiat. Soc. Bengal* LVI, pp. 32, 33 (1887).

² Kuhlitz, T., *Arch. Naturgesch. Beih.* LXVII (i), p. 215 (1901).

and 382) have noticed it only from Sikkim (Mangpu), Burma (Shwegu), Java, Timor, the Philippines and North Queensland, thus omitting its original habitat from which the species derived its name.

Coptosoma siamica Walker.

1867. *Coptosoma siamica*, Walker, *Cat. Het.* I, p. 89.
 1902. *Coptosoma siamicum*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 30, 31.
 1903. *Coptosoma siamicum*, Distant, *Fasc. Malay.* II, p. 225.
 1909. *Coptosoma siamicum*, Breddin, *Ann. Soc. Ent. Belgique* LIII, p. 258.
 1909. *Coptosoma siamicum*, Lefroy, *Rec. Ind. Mus.* III, p. 302.
 1909. *Coptosoma siamica*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 338.
 1910. *Coptosoma siamica*, Kirkaldy, *Ann. Soc. Ent. Belgique* LIV, p. 111.
 1912. *Coptosoma siamicum*, Oshanin, *Kat. paläarkt. Hem.*, p. 3.
 1926. *Coptosoma siamicum*, Esaki, *Ann. Hist.-nat. Mus. Nat. Hungar.* XXIV, p. 143.

We assign to this species sixty-four pinned specimens from the following localities:—one male and three females from Khargpur, Bengal (R. A. Hodgart, 17-30.vi.1911); one male from North-East Assam (H. H. Godwin-Austen); two males and one female from forests at Guvvaluchervu, 1,200 feet, Palkonda Hills (H. S. Pruthi, 20-22.vi.1929), four males from hills near Mathiapalli, adjoining Craigmere Road, about three miles from Yercaud, 4,500 feet (H. S. Pruthi, 9.vi.1929) and eight males and forty-three females from Yercaud, 4,600 feet (H. S. Pruthi, 4.vi.1929 “from *Lantana* flowers”), Shevaroy Hills, Salem district, South India; one male from Haddo, Andaman Islands (C. A. Paiva 24.iii.1911).

A few of the several specimens from Yercaud that we have examined have the anterior margin of the pronotum concolorous.

C. siamica is known to occur in Calcutta, Dacca and Raneeunge, Bengal; Barway and Pusa, Bihar; Bombay and Surat, Bombay Presidency; Karennee and Mergui, Burma; Ceylon; China; Indo-China; Siam; Malay Archipelago; Formosa; North Australia.

It is represented in the collections of the Zoological Survey of India from Kalka, 2,400 feet, base of Simla Hills, Punjab; Almora, 5,500 feet, Kumaon district and Bijrani, Naini Tal district, United Provinces; Rajmahal, Bihar; Mazbat, Mangaldai district, North-East Assam; Malay Archipelago; Australia.

Kirkaldy (1909, p. 338), in a footnote, remarked on the invalidity of Walker's species which he cites in the synonymy of *C. siamica*. According to Kirkaldy these species stand in need of revision.

Coptosoma noualhierii Montandon.

1902. *Coptosoma noualhierii*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 31, 32.
 1908. *Coptosoma noualhierii*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 137.
 1909. *Coptosoma noualhierii*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 335.
 1909. *Coptosoma noualhierii* var. *obscuratum*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 335.
 1918. *Coptosoma noualhierii*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 115.

We refer to this species twelve pinned examples from the following localities:—one female from Allahabad, United Provinces (R. A. Hodgart, 10.xi.1911); two males and one female from Sukna, 1,000 feet, Darjeeling district, Eastern Himalayas (Lord Carmichael's Colln., iv. 1913); one female from Calcutta, Bengal (Mus. Colln., 25.ix.1912);

three males and four females from Kukkal, 6,500 feet, Palni Hills, South India (S. W. Kemp, 29-30.viii.1922).

In the specimens from Kukkal the spots on the basal callosity of the scutellum vary in size and the broken pale anterior margin of the pronotum is absent.

The species is known from Dehra Dun, United Provinces ; Barway and Chota Nagpur, Bihar ; Palni Hills, South India ; Maha Illupalama, Ceylon.

It is represented in the collections of the Zoological Survey of India from Calcutta, Bengal ; Katihar, Purnea district, Bihar ; Hambantota, Ceylon.

Coptosoma indicum Lethierry.

1896. *Coptosoma indicum*, Montandon, *Ann. Soc. Ent. France* LXV, p. 458.
 1902. *Coptosoma indicum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 33.
 1908. *Coptosoma indica*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 136.
 1909. *Coptosoma indica*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 333.
 1909. *Coptosoma indicum*, Lefroy, *Rec. Ind. Mus.* III, p. 302.

This species is recorded from Palamau¹ and Pusa, Bihar ; Pondicherry, Madras Presidency ; Point de Galle, Ceylon ; Siam.

It is represented in the collections of the Zoological Survey of India from Barkuda Island, Chilka Lake, Ganjam district, Orissa ; Vizagapatam, Madras Presidency ; Medha, 2,200 feet, Satara district, Bombay Presidency.

Coptosoma nazirae Atkinson.

1902. *Coptosoma nazirae*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 33.
 1909. *Coptosoma nazirae*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 335.

We refer to this species forty-seven pinned specimens, comprising twenty-six males and twenty-one females, from the following localities :—Pashok, 5,000 feet (F. H. Gravely, 26.v-14.vi.1916) and Singla, 1,500 feet (Lord Carmichael's Colln., vi.1913), Darjeeling district, Eastern Himalayas ; Sikkim (Lord Carmichael's Colln., v-vi.1912).

The species is also known from Mangpu, Darjeeling district, Eastern Himalayas and Assam.

It is represented in the collections of the Zoological Survey of India from Pussumbing, 4,700 feet, Darjeeling district, Eastern Himalayas ; Sikkim ; Mangaldai, North-East Assam.

Coptosoma feanum Montandon.

1902. *Coptosoma feanum*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 33, 34.
 1908. *Coptosoma feana*, Bergroth, *Mém. Soc. Ent. Belgique* XV, p. 136.
 1909. *Coptosoma feana*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 332.

This species occurs in Mangpu, Darjeeling district, Eastern Himalayas ; Naga Hills, Assam ; Nilgiri Hills, South India ; Karennee and Rangoon, Burma ; Myitta, Tenasserim ; Malacca.

¹ This is the old name for the present Daltonganj, Bihar. Cf. *Post and Telegraph Guide*, p. 510. September 1939. New Delhi.

It is represented in the collections of the Zoological Survey of India from Mangpu, Darjeeling district, Eastern Himalayas; Sikkim; Margherita, Assam.

This species appears to be closely related to the preceding one.

Coptosoma variegatum (Herrich-Schäffer).

1839. *Thyreocoris variegatus*, Herrich-Schäffer, *Wanz. Ins.* IV, p. 83, pl. cxxxiv, fig. 414.
 1902. *Coptosoma siamicum* var. *orbicula*, Distant, *Faun. Brit. Ind., Rhyn.* I, pp. 30, 31.
 1909. *Coptosoma variegata*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 340.
 1909. *Coptosoma variegata* var. *orbicula*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 340.
 1909. *Coptosoma siamicum* var. *orbiculus*, Breddin, *Ann. Soc. Ent. Belgique* LIII, p. 258.
 1910. *Coptosoma variegata*, Kirkaldy, *Ann. Soc. Ent. Belgique* LIV, p. 111.
 1918. *Coptosoma variegatum*, Distant, *Faun. Brit. Ind., Rhyn.* VII, p. 114.
 1928. *Coptosoma variegatum*, China, *Journ. Fed. Malay States Mus.* VIII, p. 185.

We assign to this species seventy-four pinned examples from the following localities:—three males from Rangamati, Chittagong Hill Tracts, Bengal (R. Hodgart, 11-16.vii.1915); one female from Naga Hills, Assam (H. H. Godwin-Austen); one male at the Assam-Bhutan Frontier, Mangaldai district, North-East Assam (S. W. Kemp, 25.xii.1910); one male and four females from forests at Guvvaluchervu, 1,200 feet, Palkonda Hills (H. S. Pruthi, 1-3.viii.1929), one female from hills near Mathiapalli, adjoining Craigmere Road, about three miles from Yercaud, 4,500 feet (H. S. Pruthi, 9.vi.1929) and one male and four females from Yercaud, 4,600 feet (H. S. Pruthi, 4.vi.1929 “from *Lantana* flowers”), Shevaroy Hills, Salem district, South India; one female from Pakokku, 180 feet (Miss Molesworth, ix-x.1915) and one male and one female from Hopin, Myitkyina district (B. N. Chopra, 12-13.x.1926), Upper Burma; thirty males and seventeen females from Haddo (C. A. Paiva, 24.iii.1911) and three males and five females from Port Blair, Andaman Islands (S. W. Kemp, 15.ii-15.iii.1915).

The following pinned specimens, named by the late Mr. C. A. Paiva as *C. siamica* Walker, are also referable to this species:—one male from Calcutta, Bengal; two females from Purnea district and Siripur, Saran district, Bihar; six males from Bandra, Bombay Presidency; three males from Peradeniya, Ceylon; one male and one female bearing the locality-labels “Bombay” and “Ceylon”, respectively.

C. variegatum has been recorded from Gopaldhara, Rungbong Valley, Darjeeling district, Eastern Himalayas; Sahhawala, Dehra Dun, United Provinces; Ceylon; Tonkin, Indo-China; South China; Java; Sumatra; Borneo; Timor; Philippines; Papua; Sula.

Distant (1902, p. 31) considered Walker's two species, *C. orbicula* and *C. blandula* and Montandon's *C. pygmaeum* var. *accensitum* as synonyms of *C. siamicum* var. *orbicula*. Kirkaldy (1909, p. 340) regarded Walker's species and Montandon's variety as synonyms of *C. variegatum* rather than of *C. siamica* Walker. Later, Distant (1918, p. 114) followed Kirkaldy's modification. China (1928, p. 185), in his synonymy of *C. variegatum* refers only to the more important literature relating to the species (*i.e.* Herrich-Schäffer, *loc. cit.*, p. 83 and Montandon¹).

¹ Montandon, A. L., *Ann. Mus. Civ. Stor. Nat. Genova* (2) XIV, p. 134 (1894).

Coptosoma fimbriatum Distant.

1902. *Coptosoma fimbriatum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 34.
 1909. *Coptosoma fimbriata*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 332.
 1909. *Coptosoma fimbriata* var. *cingulatum*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 332.

We refer to this species twenty-two pinned examples from the following localities:—two females from Kurseong (F. Stoliczka), one male and one female from Pankabari (F. Stoliczka), one male and two females from Soom, 4,000-5,000 feet (Lord Carmichael's Colln., 7-8.vii.1914), one male and two females from Pashok, 4,500 feet (F. H. Gravely, 26.v-14.vi.1916) and five males and two females from Sureil, 5,500 feet (N. Annandale and F. H. Gravely, 11-31.x.1917 "on spiny nettle"), Darjeeling district, Eastern Himalayas; two males and females from Cherrapunji, Khasi Hills, Assam (S. W. Kemp, 2-8.x.1914) and one male from North-East Assam (H. H. Godwin-Austen).

Some of the specimens listed above which we have determined as *C. fimbriatum* do not entirely conform to Distant's description. In the five males and the two females from Sureil the dorsal aspect of the body and the abdomen ventrally are purplish-black or metallic in colour and the first two apical joints of the antennae are infusate; the one male and the two females from Soom and the two males and the one female from Pashok, besides having the first two apical joints of the antennae infusate have the ochraceous lateral anterior dilated margins of the pronotum intersected by a black line, the lateral and the apical margins of the scutellum ochraceous and an ochraceous marking at the apex of each abdominal segment.

As will be noticed from the foregoing remarks, *C. fimbriatum* is a rather variable species. Montandon¹ established the variety *cingulatum* on account of the presence of the markings at the edges of the scutellum and the apices of the abdominal segments but as these features are also present in the specimens that we have studied, we consider Montandon's variety as belonging to the species itself.

C. fimbriatum has been recorded from Kurseong, Darjeeling district, Eastern Himalayas, Sikkim and China.

Coptosoma testacea Walker.

1867. *Coptosoma testacea*, Walker, *Cat. Het.* I, p. 91.
 1902. *Coptosoma testaceum*, Distant, *Faun. Brit. Ind., Rhyn.* I, p. 34.
 1909. *Coptosoma testacea*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 340.
 1909. *Coptosoma testacea* var. *immaculata*, Kirkaldy, *Cat. Hem. (Het.), Cimicid.* I, p. 340.

The species is represented in the collections of the Zoological Survey of India by forty-one pinned specimens, comprising twenty-one males and twenty females, all from Calcutta.

It has previously been recorded from Calcutta, Bengal and Java.

¹ Montandon, A. L., *Ann. Soc. Ent. Belgique* XL, p. 435 (1896).

